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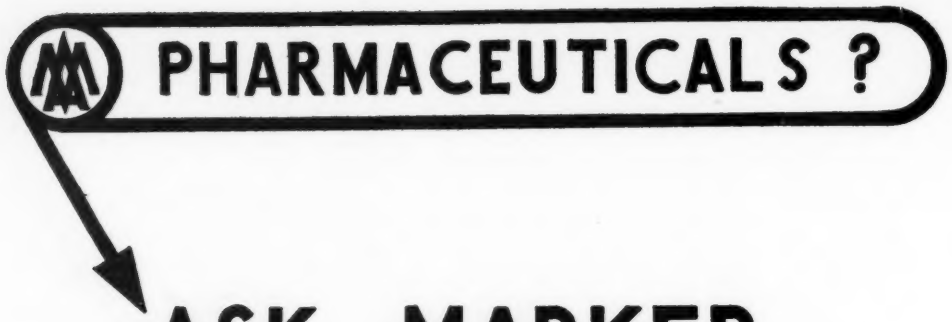

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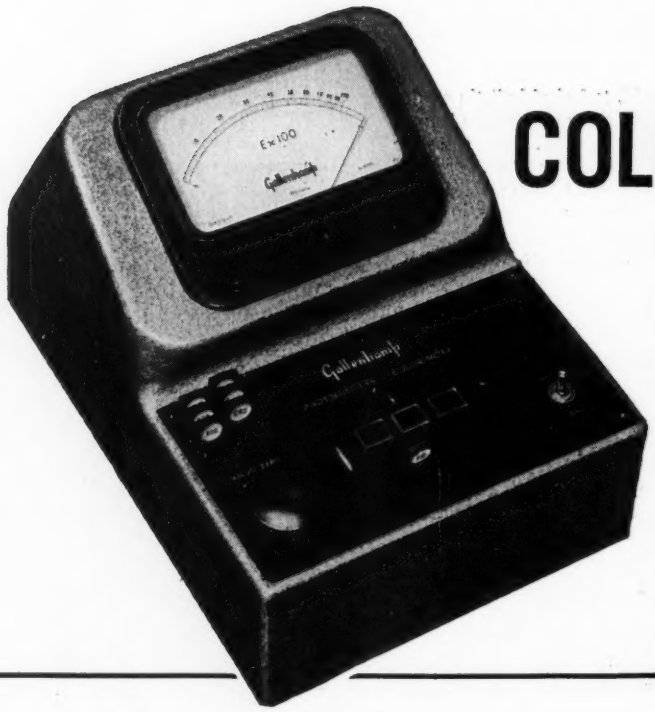

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THE DESIGN OF A SIMPLE URANIUM-THORIUM DISCRIMINATOR FOR WEAKLY ACTIVE ORES CONTAINING LESS THAN 1% U_3O_8 EQUIVALENT

Part II.—Design, Use and Testing of Discriminator

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(Received May 4, 1961)

1. Basis of the Design

In Part I of this communication,[1] a critical analysis was made of the measurements of beta and gamma activity from various thicknesses of samples containing around 0.1% of the metals uranium and thorium in approximate equilibrium with their decay products. This analysis indicated the feasibility of using the following ratios (cf. Fig. 1) for good discrimination between uranium and thorium:

(1) $\frac{1}{R_4}$,

where $R_4 =$

$$\frac{\text{Near saturation gamma ray counts from (8 g/cm.}^2\text{)}}{\text{Saturation beta counts}}$$

(2) $\frac{1}{R_3}$,

where $R_3 = \frac{\text{Gamma slope at 4 g./cm.}^2}{\text{Origin (beta + gamma) slope}} \times 100$

Of these two ratios, the second one gives the better discrimination, but this is offset by the fact that the first ratio can be obtained from one measurement only of the beta and gamma counts respectively whereas the second requires at least three measurements of comparatively higher accuracy, each with a different sample thickness. It is therefore preferable to use the first ratio as the basis of the design of a simple discriminator. On

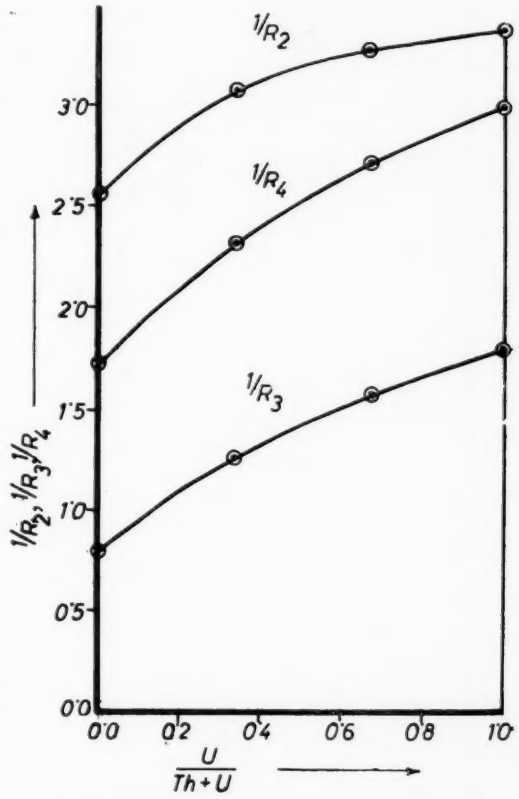

Fig. 1.—Previously reported graphs for the values of 0.1/R_2, 1/R_3 and 1/R_4, for different ratios of uranium/(uranium + thorium).

*Now with the Pakistan Atomic Energy Commission, Karachi.

this basis, we require a sample thickness corresponding to about 8 g./cm.^{2}, which would correspond to a thickness of a little over 5 cms. for a mineral sample with an apperant density of 1.5 g./ml. in the powdered state (approximately 2.5 as solid rock).

2. The Dimensions of the Sample Container

In the measurements described in Part I, the counter was placed above a slab of the sample under test, and this method is desirable when the effect of varying sample thickness is being studied. However, this is not the most efficient arrangement in respect of counts/g. of material, because only a small fraction of the total solid angle (4π) is utilized. The use of a simple double-walled cylindrical container as shown in Fig. 2 is a convenient way of increasing the efficiency very considerably.

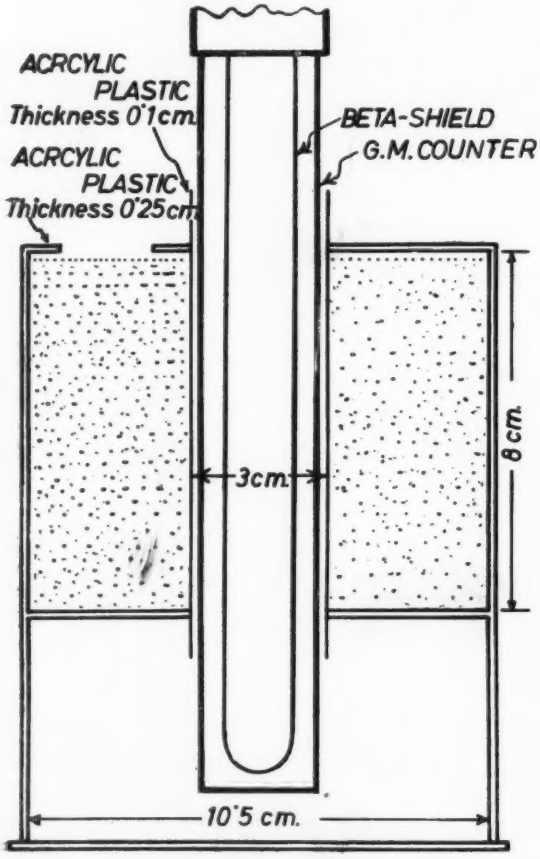

Fig. 2.—Cylindrical discriminator: diagrammatic sketch.

Now $1/R_4$ is the ratio of the saturation beta counts to the gamma counts from a sample of thickness of the order of 8 g./cm^2. Both these quantities can be obtained if we use an annular cylindrical container with an inner radius R_i just greater than that of the tube counter (with beta-shield), and outer radius R_o of 6 to 8 cms., which will give a sample thickness of about 5 cms. corresponding to about 8 g./cm^2.

Two different counting systems were tried out, one with a scaler unit in conjunction with a probe unit and H.T. power supply, and the other with a ratemeter circuit. Two slightly different cylindrical containers were made out of transparent acrylic plastic 2.5 mm. thick for use with the two counters. The dimensions of one of them are shown in the sketch of Fig. 2, from which it is seen that the counter tube collects radiations from a solid angle somewhere around 2π i.e. one half of the maximum possible. Of course there will be a relative bias against the gammas coming from near the circumference of the container, because of the smaller solid angle subtended at the counter. This will tend to give larger values for $1/R_4$ than with the flat samples.

3. Use of Discriminator

After noting the background counts, the (extra) counts obtained when the unshielded counter tube is inserted in the central hole will correspond essentially to the saturation beta counts from the layer within 1 cm. of the inner wall, because (a) the contribution from the gamma counts is small, and (b) the small thickness of the inner wall of the container is equivalent to about 0.05 g./cm.^{2}, which is considerably smaller than the thickness (0.3 g./cm^2.) required to produce a reduction of 1/e in the beta counting rate from various samples containing uranium and thorium. When the beta-shield tube is inserted between the counter tube and the cylindrical hole in the sample container, only the gamma counts from the whole mass of the sample are recorded. Thus two measurements, with and without the beta shield tube, give estimates of the saturation beta counts and the gamma counts from a thickness of about 8 g./cm.^{2}, and their ratio directly gives the quantity corresponding to $1/R_4$. It will differ from the $1/R_4$ as determined from a flat sample (cf. Part I) be cause while the beta effective part of the annular sample is only slightly separated from the counter, giving a large effective solid angle for the beta counts, this solid angle will be considerably smaller for the gamma counts.

This cylindrical type of discriminator was first tested with two standard preparations containing

0.5% thorium nitrate and 0.5% uranyl acetate, respectively, in calcium carbonate. The mixing was done by successive dilutions in solid phase and the weight of the sample in both cases was about 500 g. The actual counts obtained with a G.M. Counter-FHZ 69 and scaler are given in Table 1, and are seen to be 2 to 3 times those previously obtained with the flat sample. The value of R_4 is found to be 0.31 for thorium and only 0.01 in case of uranium, more or less as expected.

Since it is known that natural radio-active materials are very nearly in equilibrium, whereas our standards may be in equilibrium with only the first two or three decay products, samples containing 10% and 1% low-grade pitchblende (having 7% uranium) were next tested. The value of R_4 was also determined for a mixture containing thorium (0.05% thorium mixture) and uranium (0.05% uranium from pitchblende) in equal proportions. These results are also shown in Table 1.

TABLE 1.

Sample	Excess gamma counts/min. (a)	Excess beta counts/min. (b)	$R_4=(a)/(b)$	$1/R_4=(b)/(a)$
0.5% Thorium nitrate ..	25.2 ± 0.2	82 ± 2	0.31	3.2
0.5% Uranyl acetate ..	4.5 ± 0.8	540 ± 8	0.01	120
10% Low grade pitchblende (i.e. 0.7% uranium)	200 ± 3	1500 ± 15	0.13	7.5
1% Pitchblende .. (i.e. 0.07% uranium)	19.1 ± 1	147 ± 5	0.13	7.7
50-50 mixture of 0.05% thorium with 0.05% uranium from pitchblende ..	22.0 ± 1.3	118 ± 3	0.18	5.4

TABLE 2.

Sample	Excess gamma counts/min. (a)	Excess beta counts/min. (b)	$R_4=(a)/(b)$	$1/R_4=(b)/(a)$
0.5% Thorium nitrate	61.0 ± 3	122 ± 10	0.50	2.0
„ „ „ ..	53.7 ± 3	169 ± 10	0.32	3.1
„ „ „ ..	49.8 ± 3	156 ± 10	0.32	3.1
Mean	54.8 ± 6	149 ± 10	0.37	2.7
0.5% Uranyl nitrate	18.9 ± 1	1610 ± 20	0.012	85
„ „ „ ..	19.5 ± 1	1709 ± 20	0.011	85
Mean ..	19.2 ± 2	1660 ± 50	0.012	85

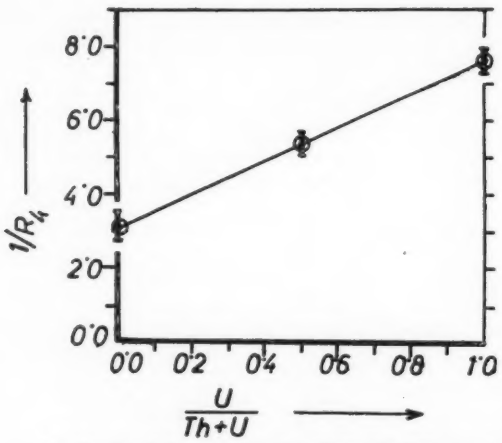

Fig. 3.—Graph showing the value of $1/R_4$ for different ratios of uranium/(uranium + thorium) obtained with the cylindrical discriminator of Fig. 2.

Another series of observations was taken using a G. M. counter in conjunction with a Labgear Laboratory Ratemeter type D.4101, the inner and outer radii of the discriminator made for this work being 3.8 cms. and 13 cms. respectively. For each measurement, the readings of the ratemeter were recorded every half minute for about 5 to 10 minutes and then the mean of these readings was obtained. Table 2 shows the actual counts. The value of R_4 in this case is found to be 0.37 for thorium and 0.012 for uranium. These values are slightly higher than those from the previous set of readings, cf. Table 1.

4. Discussion

Figure 3 shows the graph between $1/R_4$ and the ratio uranium to (uranium + thorium) in a mixture of uranium (in equilibrium) and thorium. The graph is nearly linear. Comparing the observations for pitchblende with chemically separated uranium, it is noted that while the beta counts are not greatly influenced by the equilibrium products, the gamma counts are increased manifold. Thus, any considerable lack of equilibrium will tend to increase the value of $1/R_4$ and therefore lead to an underestimate of thorium in relation to uranium.

Reference

1. K. Husain, M. Azeem N. Ahmed and M. M. Qurashi, Pakistan J. Sci. Ind. Research, **1**, 273 (1958).

STATISTICAL CONTROL OF LOG BREAKDOWN*

A. C. Barefoot, Jr.

Pakistan Forest Research Laboratory, Chittagong

(Received May 10, 1961)

Careful attention to the manner and precision of sawing logs into lumber has been frequently and strenuously advocated by leading lumber specialists of scientific and industrial organizations. This advocacy has had as its purpose the maximizing of the yields of the higher grades of lumber. Since these higher grades of lumber are almost invariably in short supply, the consequent demand for these items is good and prices are normally high. The thought and energy expended in presenting these pleas for better milling procedures has intensified the awareness of the problems associated with decreased log size and lower yield values of these logs. It certainly is good economics to obtain the highest yield of the upper grades of lumber consistent with maintaining a reasonable production rate. In particular Telford,[9] Smith,[8] Brown and Bethel,[4] and others have emphasized the necessity of using correct methods of sawing for maximizing the yields of the higher grades of lumber. Bethel and Barefoot[3] indicate the sawyer's job is one of those prime positions where the decisions of one man, properly made, are extremely vital to the economic well being of a lumber manufacturing operation. The application of statistical quality control procedures to grade recovery of lumber which would be comparable to those used in controlling dimensions could be extremely valuable to the sawmilling industry.

No systematized mathematical approaches have been developed for evaluating the breakdown of logs into lumber. Statistical quality control procedures, such as Shewart's original p-chart[7] have not been applied to log breakdown because of the complexities arising from the number of log grades, the number of lumber grades, and the slowness with which data could be collected and interpreted. There being a definite need for controlling the processes concerned with log breakdown, this study was undertaken primarily to provide a systematic method of control in evaluating the correctness of log sawing procedures for single logs as well as groups of logs. A simple system would require the adoption of a statistical procedure which could be readily computed, pictorially presented, and easily interpreted for controlling the percentages of lumber yields by grades from logs.

*A paper based on work at the School of Forestry, North Carolina State College, Raleigh, N. C., U.S.A.

The opinion existed that the p-charts and Chi-square charts were not desirable for solving the problem of controlling grade yields. The objection to using the p-chart for logs concerns the necessity for maintaining a chart for each lumber grade with each log grade; for all logs sawn a collective picture for immediate evaluation or control is difficult to obtain from these unrelated charts. On the other hand, the Chi-square chart could be adapted to combine all the yields of all the logs on one chart but it lacks simplicity of interpretation since not only a constant sample size is required but the chart does not directly evaluate the quality in question. This study was undertaken for developing a control procedure involving many percentages as found in lumber yields at a sawmill.

Procedures of the Study

The initial work of the study centered about developing a trial control procedure applicable to the lumber yields of logs. The criteria for such a method were these:

(1) One chart was desirable for presenting the results of sawing all logs regardless of their grade.

(2) Computations should be fairly simple, direct, and understandable.

(3) The control chart should provide the means for ferreting out the assignable causes associated with wrong cutting procedures.

(4) If possible, Shewart's X and R charts were to be the basis of the control procedure used.

Under these criteria an analysis method was outlined and used at two saw mills cutting yellow poplar (*Liriodendron tulipifera* L.) lumber. At these mills the randomly selected logs were scaled, graded into No. 1, No. 2, No. 3, and No. 4 logs and observed during sawing for any unusual occurrences. Following cutting, the lumber from the logs was graded into the standard hardwood lumber grades for yellow poplar and tallied. The resulting data were plotted on charts (Figs. 1 and 2) according to the first of the schemes presented in the next section. Subsequent study of these chart led to their rejection as a satisfactory means of controlling the grade recovery of hardwood logs. The second scheme, with its charts (Figs. 3 to 7)

presented in this report was then adopted for trial. All the results were analyzed as to their effectiveness in controlling log breakdown.

The Mathematical Procedures

The first approach to controlling grade recovery was made through a set of indexes plotted on $\bar{X}$ and R charts; the second procedure involved a refinement of the p-chart. Both plans made use of the data generated in the study as follows:

(1) Standard indexes, ϕ 1, were computed from data in the Forest Products Laboratory log grade report[1] for No. 1, No. 2 and No. 3 logs. For No. 4 logs this index was computed from unpublished data.[5] The standard value ϕ 1, was selected for each log grade by finding that percentage of yield of a lumber grade or combination of grades which approached 0.50. For example, from No. 1 yellow poplar logs the proportion of No. 1 Common lumber expected is stated to be 0.457 (1). Arbitrarily then ϕ 1 = 0.457. Appropriate selections gave:

a. No. 1 logs proportion of No. 1 Common lumber = 0.457 = ϕ 1
b. No. 2 logs porportion of F & S and No. 1 Common lumber = 0.466 = ϕ 2
c. No. 3 logs, proportion of No. 1 Common and 2-A lumber = 0.491 = ϕ 3
d. No. 4 logs, proportion of 1-A and 2-B lumber = 0.553 = ϕ 4.

(2) For each log graded, sawed, and tallied by lumber grade a quantity

$$B_j = \frac{P_j}{\phi_i}$$

was computed where P_j was the observed proportion of lumber from the jth log falling into the same classification used in selecting ϕ_i for that grade of logs. For example, a No. 1 log producing a total 180 board feet of lumber and having 100 board feet of No. 1 Common lumber would have a B1 value as below:

$$B_1 = 0.556/0.457 = 1.217$$

(3) At this step the two procedures used to analyze the data diverge and the results of plotting the charts are quite different. The assumptions concerning the approximate variances will be developed as each procedure is further explained.

In the first proposal the normal distribution was assumed to describe the averages of a set of Bj's. For this reason the data was subgrouped into sets of four Bj's; $\bar{X}$ and R charts were then used as in standard Statistical Quality Control analysis. The Bj's were recorded and statistics computed for the data of two sawmills as illustrated in Table 1.

TABLE 1.—SAMPLE DATA SHEET FOR Bi's.

Sub-group	Bj Observations				$\bar{X}$	R
1	1.11	0.35	0.63	0.93	0.75	0.76
2	1.60	0.69	0.83	1.61	1.18	0.92
:	:	:	:	:	:	:
:	:	:	:	:	:	:
N	1.79	0.25	0.00	0.88	0.73	1.79

There seeming to exist a situation involving "too-good" control, several simple subgrouping variations of these data were tried for interpreting the data. There being nothing suggesting that a new subgrouping method would solve the situation of "too-good" control (Figs. 1 and 2) of the above procedure, a new P-1 charting technique, the second approach adapted, was formulated and scrutinized. Since this control charting procedure seems to hold some merit for use in other that log and lumber studies, the theory of the P-1 control chart is presented in more detail.

For the purposes of pictorial presentation of percentage figures and their appropriate three sigma limits Shewart[7] suggested the use of a p-chart. This chart was based on the binomial distribution of statistical theory and is fully explained in Grant's[6] text. Briefly the theory is based upon dividing a given population of things into two groups, A and B, and stating the resulting division in terms of proportions thusly:

$$P_A = \frac{\text{Number of A objects}}{\text{Total objects}} \qquad (1)$$

or

$$P_B = \frac{\text{Number of B objects}}{\text{Total objects}} \qquad (2)$$

where P_A or P_B is the proportion of A objects or B objects to the total number of A and B objects. The variance of sample proportions can be shown to be.:

$$V(p) = \frac{p\,q}{n} \qquad (3)$$

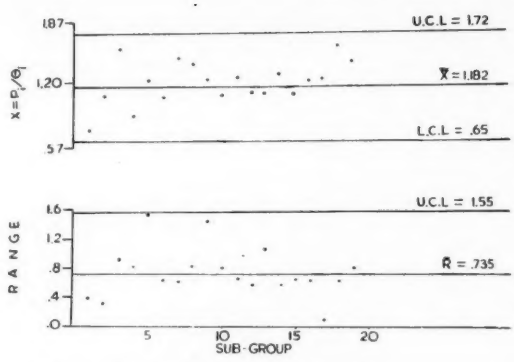

Fig. 1.—X and R Control Chart For Mill A.

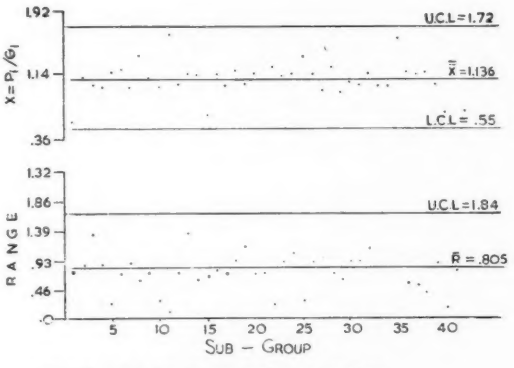

Fig. 2.—X and R Control Chart for Mill B.

where n = number of objects in a sample, p = proportion of a given object in a sample of size n, q = 1 − p

The p-chart for control purposes then is calculated and plotted according to the ASTM Manual[2] with limits equal to

$$p \pm 3\sqrt{\frac{\bar{p}\ \bar{q}}{n}} \qquad (4)$$

where p is an average fractional proportion of many samples and n is the number of a given sample for which one value of p is computed.

It is obvious from an examination of the Forest Products Laboratory's work[4] that within each log grade, yields of each lumber grade vary from the corresponding yields of the other log grades, for example, the percentage yield of No. 1 Common lumber of a given species of logs from No. 1, No. 2 and No. 3 logs might be represented by $\overline{p_1}$, $\overline{p_2}$, and $\overline{p_3}$ respectively. Three charts would be required if p-charts were used for control purposes. However, if the stadnard yield, ϕ, as developed in paragraph (1) of this section of a given grade of lumber is established for a given log grade such that B_j has the expected value of 1.0

$$E(B_j) = E\frac{P_j}{\phi_1} = 1.00 \qquad (5)$$

then the possibility of incorporating P_1, P_2, and P_3 into one chart exists since $E(B_1)$, $E(B_2)$ and $E(B_3)$ should all have the same mean. Therefore, we may calculate by summing over all grades, the quality

$$\bar{B} = \frac{E(B_j)}{\text{Number of samples}} \qquad (6)$$

The selection of the appropriate variance remains. Since the variance of p is

$$V(p) = \frac{p\ q}{n} \text{ and}$$

$$V(\phi) = 0 \text{ by definition}$$

then

$$V\left(\frac{P}{\phi}\right) = \frac{p\ \ q}{n\ \phi^2} \qquad (7)$$

Letting $\frac{p\ \ q}{\phi 2} = K^2$ then

$$V\left(\frac{P}{\phi}\right) = \frac{K}{n} \qquad (8)$$

As $\phi \rightarrow 0.50$ then $E(P) \rightarrow 0.50$ (from 5) and

$$V\left(\frac{P}{\phi}\right) \rightarrow \frac{1}{n} \qquad (9)$$

It is not necessary that the ϕ's approach 0.50 or that they all be of the same value but if they are so chosen as to be practically equal and nearly 0.50, then the greatest variation in a control chart's limits will be caused by varying sample size. As will be shown, this variability of the limits can all but be ignored in working with logs and selected lumber yields. Selection in this manner also provides the narrowest limits possible.

Following this theory a p-1 control chart can be plotted with the values from entirely different

origins, i.e., logs of different grades. Letting the central line equal $\bar{B}$, then the limits are defined as:

$$\text{Control limits} = \bar{B} \pm 3\sqrt{\frac{\bar{K}}{\bar{N}}} = \bar{B} \pm 3\,s \quad (10)$$

As is the usual procedure with SQC charts any point falling outside a three sigma limit line is investigated for the presence of an assignable cause. The points which are out of control may also yield information on the origin of the trouble as do similar points on the $\bar{X}$ and R charts. This feature overcomes the objection to the Chi-square chart which merely records the evidence of agreement to some standard. Points falling consistently high or low also aid in controlling the process or in improving the process when careful and correct decision-making is evidenced. P-1 charts were prepared as above for each of the five saw-mills selected for study. These mills were located in the Piedmont and mountains of North Carolina. Due to the circumstances of collecting the data, very little experimentation on sawing order or procedures could be practised or effectively suggested; therefore, the charts presented merely reveal the history of each operation with no corrective actions recorded. The p-1 chart for each mill was then drawn according to the following practice using formula 10:

(1) $\bar{B}$ = central line

(2) Upper and lower control limits.

a. For logs of grade 1 : $\bar{B} \pm \frac{3\,(1.09)}{\sqrt{n}}$

b. For logs of grade 2 : $\bar{B} \pm \frac{3\,(1.07)}{\sqrt{n}}$

c. For logs of grade 3 : $\bar{B} \pm \frac{3\,(1.02)}{\sqrt{n}}$

d. For logs of grade 4 : $\bar{B} \pm \frac{3\,(.899)}{\sqrt{n}}$

The letter, n, is the total board footage yield of all grades of lumber from a given log.

Table 2 gives the calculations for the exact control limits for the first ten points of Fig. 3. The value for $\bar{B}$ in Fig. 3 and Table 2 is based on data from the first 48 logs studied at Mill A.

TABLE 2.—SAMPLE DATA COMPUTATIONS FOR P-1 CONTROL CHART OF MILL A.

Log Number	Log Grade	Board Footage Yield n	Bj		Upper Control Limit	Lower Control Limit
1	1	263	1.11	.057	1.34	.94
2	1	208	0.35	.076	1.35	.91
3	1	223	0.63	.073	1.36	.92
4	1	156	0.93	.037	1.40	.88
5	2	227	1.60	.071	1.35	.92
6	1	232	0.69	.072	1.35	.92
7	1	248	0.83	.069	1.34	.93
8	2	187	1.61	.078	1.36	.91
9	2	282	1.67	.064	1.33	.94
10	4	103	0.33	.089	1.40	.87
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;						
168						

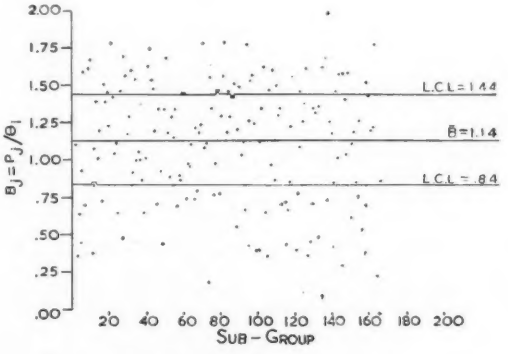

Fig. 3.—P1 Chart For Mill B.

Generally a preliminary $\bar{B}$ may be safely calculated from the first 20-25 logs.

$$B_j = \frac{P_j}{\phi_{1,\,2,\,\text{or}\,3}}$$

$$\bar{B} = \frac{\sum_{j=1}^{48} B_j}{48} = 1.136$$

Control limits $= \bar{B} \pm 3\,s$; formula 10

Trial control limits for the P-1 chart may be derived for all except questionable points by using these empirical rules for the selection of n in formula 10:

(1) For logs which will average 100-135 board feet, substract 13 from the average and use a value of n = 87-122 accordingly.

(2) For logs which will average 60-80 board feet, substract 12 from the average and use a value of n = 48-68 accordingly.

(3) For logs which will average about 45-60 board feet, substract 11 from the average and use a value of n = 34-49 accordingly.

Trial limits based on the above procedure are shown on the charts of Figs. 3-7 and are corrected for some of the questionable points as shown. These corrections follow the standard practices used when a p-chart having variable samples sizes is plotted with constant trial limits.

Interpretation of Results

A rather casual examination of Fig. 1 would lead a quality control technician to exclaim with joy, 'At last a process immediately in control.' Yet, with Fig. 2, which represents another mill's process and this too is immediately 'in control' the same technician should suspect that some errors in assumptions have been made with respect to the charting technique in use. For it is almost axiomatic that no manufacturing process is ever completely and always in statistical control. Further, almost no process approaches a state of being in control when first studied. For this reason careful attention was turned upon these charts; different subgroupings were tried, but basically the same conclusion was reached in each case. The technique used in plotting Figs. 1 and 2 resulted in charts which showed a state of 'too good' control. Obviously, the variation within the subgroups was too large for use in computing the three-sigma limits

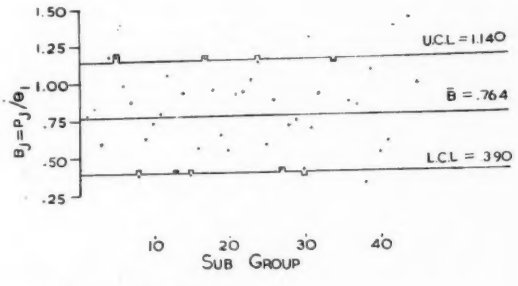

Fig. 4.—Pl Chart for Mill C.

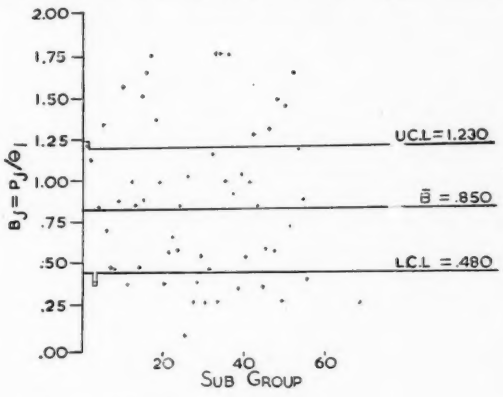

Fig. 5.—Pl Chart for Mill D.

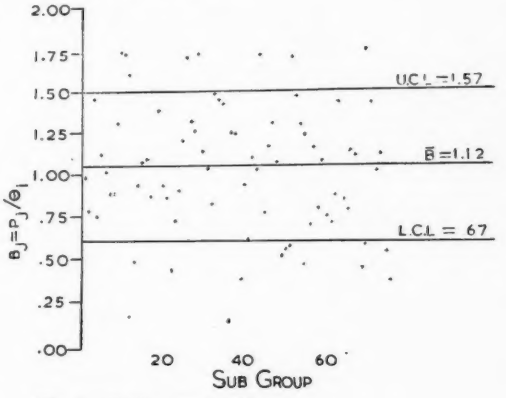

Fig. 6.—Pl Chart For Mill E.

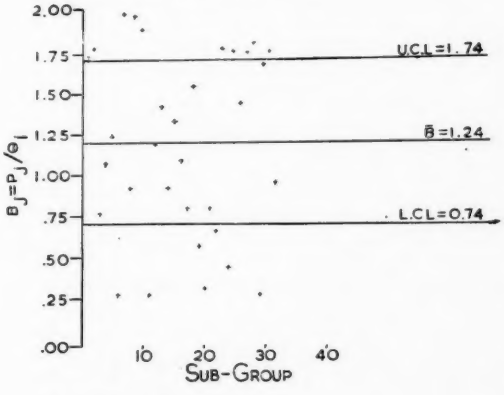

Fig. 7.—Pl Chart for Mill A.

of an $\bar{X}$ and R chart. Perhaps arbitrarily the selection of two sigma limits would solve this problem for a practical operation. But this approach leaves much to be desired since these limits could still give false assurances of having a well organized cutting procedure when in fact such may not be. For this reason attention was directed to the new P-1 charts for a more detailed analysis of the data of this study.

These charts, too however, reveal what might be a deficiency in the theoretical assumptions. As observed in Fig. 4 nothing appears seriously wrong but Figs. 3, 5, 6 and 7 suggest a state of serious lack of control. Perhaps this is due to the reverse of the case of 'too good' control in the $\bar{X}$ charts. This situation emphasizes the absence of basic statistical information on the distribution function describing lumber yields. Only a study of lumber yields by a defined and experimentally controlled sawing would establish the distribution function describing these yields from logs. All the assignable causes of variation would need eliminating from such an experiment, if possible, but such a project would have direct application to future log grade studies.

The evidence from these two charting techniques certainly suggest that the distribution function of the average yields of lumber by grade from yellow poplar logs is approximated neatly, neither by the normal distribution nor the binomial distribution.

On the other hand, one could assume that the binomial does hold and that there are a host of assignable causes yet to be defined. Under this assumption and adequately forewarned, one can interpret the data presented in Figs. 3-7 with some degree of confidence. The remarks in the remainder of this section will be confined to the charts of Figs. 3-7 under the forewarned assumption.

A casual examination of Figs. 3-7 reveals obvious differences in the yield levels based on the parameters as selected. Some of this difference could be attributed to better or worse logs as taken from any tract of timber. Yet, a closer scrutiny of the charts shows that four of the mills were getting higher yields than expected of the grades selected for study. The generally higher yield levels could be attributed to a difference in the grading standards of this study and the standards imposed in collecting the data from which parameters, ϕ_i, were selected. If so, the indication is that differing yields of various studies could be traced to difference in human judgement and interpretation of grade rules.

Two other examinations should also be made, The differing yield levels of the five mills may have been due to different sawyers or to various sources of logs or to a combination of these two variables. There are available no quantitative data substantiating the thesis that yields within a log grade vary with locations but neither is there any such data on sawyers. Before precise statements could be made, these two items would need definitive study. It is, however, much easier to subscribe to the theory that the sawyers have much more influence on lumber yields than the source of a given set of logs. Therefore, until evidence to the contrary is presented, it is safe to assume that sawyers, in making decisions on sawing procedures, do exert an influence on yields. The lack of control evidence in the charts of this study suggests, therefore, that they are not doing a consistent job.

Log size, as such, would appear from these studies to have little affect on the state of control. The logs on which Fig. 3 was based averaged 127 board feet in size. The operation was evidently out of statistical control, whereas the logs on which Figs. 4 and 5 were based averaged 94 and 85 board feet respectively. The mill which is represented by Fig. 4 seemed to be the best controlled mill found in the study, while the mill of Fig. 5 was among the worst. It would appear then that log size alone cannot be used in explaining the lack of control or a state of better control.

Peculiarly enough, as noted in an earlier paragraph, the data of Fig. 4 indicates a low level yield of those grades chosen for control purposes. Tracing this information back to the original data revealed that more of the lumber which was produced in this mill was of higher grades than expected. This mill actually was recovering more of the higher grades of lumber than any of the other mills. Again, one must ask, 'Which is responsible, the sawyer or the source of the logs?' No satisfactory evidence is available. It can be pointed out, however, that the mills of Figs. 4 and 5 were located within a few miles of each other.

Further evidence of the lack of effective decision making can be implied by comparing the range of values of Figs. 3 and 5-7 which are out of control. Regardless of log size or overall yield level, all these mills cut some logs approaching the minimum percentage possible within a grouping, i.e., zero to one hundred percent. In some few cases assignable causes could be found for these points out of control. Occasionally it was established that a point out of control was due to one of the following:

(1) Gross inaccuracy in log grading.
(2) Incorrect sawing procedures.

(3) Decayed zones in the interior of solid-looking logs or other hidden defects of broad scope in the log.

(4) Borderline decisions about the log grade. Usually a combination of 2 and 3 was cited as a basic cause. This only, though, because the sawyers usually paid little attention to turning for grade.

The lack of precision in the log grades, lumber grades, sawing decisions and grading decisions probably contribute heavily to the variability recorded. In terms of the present system of classifying yellow poplar logs and lumber yields from those logs, the variability of the data is extremely large and unexplainable. Quite evidently much basic information needs gathering through totally new approaches such as are now being used by several laboratories.

Disregarding the base source of data one can still place some confidence in the P-1 charting technique presented in the paper. Given a set of controllable conditions, the method would appear to be workable; certainly Fig. 4 would lend support to this conviction. A fair trial, using data from sources other than logs and conducted under better conditions, would be in order.

Summary and Conclusions

Any true summary of this study must point out the failure to control the grade yields of lumber from yellow poplar logs using the techniques worked out during the course of the research. Certainly, any attempt at controlling these yields is handicapped by our present limited knowledge about predicting the interior appearance of a log and the resulting yields of lumber by grades.

The use of a control charting technique comparable to those used in controlling dimensions did not prove acceptable. These charts immediately suggested a state of 'too good' control. They were abandoned as effective means of controlling the grade recovery of lumber in logs.

The development of the P-1 charts seems valid in theory and in one mill, of the five studied, evidence of its usefulness is presented. The other four mills are shown as being widely out of control on the P-1 charts with respect to the expected yields of lumber from logs of a known grade. Some reasons for this state of great variability are given in the body of the report and are the basis for these conclusions:

(1) An accurate and precise prediction of the grade yields of individual yellow poplar logs is not predictable through use of the present control systems.

(2) The P-1 chart is a feasible charting technique for combining several percentages of interest into one master percentage control chart.

(3) As shown by the P-1 chart the level of grade yields of yellow poplar varies from mill to mill. There is no specific data suggesting this is a difference attributable either to the sawyer or to the source of the logs.

(4) Log size in itself does not appear to influence the state of control existing at a given mill.

(5) Of the five mills studied, only one approached a state of statistical control when using the new conrtol technique.

These conclusions and the study firmly suggest the dire need for some imaginative and ener,getic research directed toward finding a mean of predicting the internal appearance of a log. Perhaps, the basic distribution of lumber yields by grades within logs of a given grade should be established. The investigations of this study suggest that of the two basic theoretical distributions assumed and used, neither adequately described the data to the desired degree of precision. Without a further basic study for identifying and eliminating assignable causes in the practice of sawing logs, there can be no effective statistical control procedures applied to this all important decision making step in the manufacture of lumber.

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INVESTIGATIONS ON CAESALPINIA BONDUCELLA

Part II.—Chemical Examination of the Leaves

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Chloroform extraction of the leaves gave a white amorphous bitter principle, $C_{24}H_{32}O_8$, m.p. 119-120°C. in 0.035% yield and a waxy material. Infrared spectra of the bitter shows that it contains hydroxyl and acetoxyl groups and also probably furan ring. The presence of furan ring is further indicated by colour reactions. Saponification of the wax has given myristic acid and a non-crystalline alcohol. The debittered and dewaxed leaves on alcohol extraction gave a highly crystalline sweet product, m.p. 187°C., in about 4% yield ; this compound has been characterised as pinitol. A small proportion of a reducing sugar characterised as glucose has also been detected in the leaves.

Introduction

As described in previous communications[1,2] *Caesalpinia bonducella* is a wild medicinal plant abundantly available in East Paskistan. The entire plant is used medicinally. The constituents of seeds have been described in Part I of this series of papers. The leaves of this plant are also bitter and they have been in use as an antimalarial for a long time although to a limited extent. A survey of literature has shown that no attempts have ever been made so far to examine the bitter or other constituents of these leaves. The success achieved in these laboratories in isolating crystalline bitter principles from the seeds stimulated our interest to examine the leaves as well.

The dry mature leaves were first extracted with chloroform at room temperature. The extract after removal of the chlorophyll and solvent gave a petroleum ether insoluble amorphous greyish white bitter substance, m.p. 46-65°C., and a petroleum ether soluble bitterless waxy material. The bitter substance on being chromatographed through alumina column afforded in poor yield a pure white amorphous bitter melting sharply and constantly at 119-120°C. This compound has a molecular formula, $C_{24}H_{32}O_8$. It is highly soluble in common organic solvents but it does not dissolve in petroleum ether and water and all attempts to crystallise it failed. It is optically inactive and is neither an acid nor a lactone as it does not dissolve in caustic alkali even when heated. It is not a glycoside either, since its acid hydrolysis does not afford any reducing sugar. It, however, gives a positive hydroxamic acid test suggesting it to be an ester. The ester character of the compound must be at least partly due to the acetyl group, the presence of which has been strongly indicated by the appearance of a prominent characteristic peak at 1233 cm. $^{-1}$ in the infrared absorption spectra of this compound,[3] (full curve in Fig. 1) which also indicates the presence of hydroxyl group[4] in it at 3596-3460 cm. $^{-1}$. The peak at 1749 cm. $^{-1}$ is due to ester carbonyl,[3] presumably the acetyl carbonyl. Although colour reactions of this compound such as its reaction with *p*-dimethylaminobenzaldehyde and concentrated hydrochloric acid,[1] with Shear's reagent[5] and reaction with acetic anhydride and concentrated

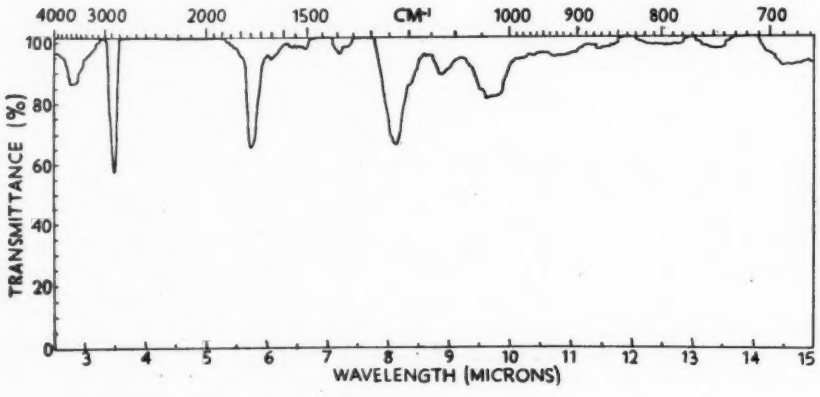

Fig. 1.—Infrared absorption spectra of the white amorphous bitter principle, $C_{24}H_{32}O_8$, m.p. 119—120°C.

sulphuric acid[5] all give positive indications for the presence of furan ring, the physical methods do not fully confirm it. Thus while the two expected peaks for furan rings[6] at around 1505 and 875 cm.$^{-1}$ in infrared spectra only appeared as very weak peaks, the expected bank[1,7] at ca. 215 mμ in the ultraviolet spectra was completely absent. Further investigations are in progress.

The waxy material on saponification gave an acid and an alcohol. The acid is a crystalline compound, m.p. 54°C., which gives an anilide, m.p. 83-84°C., and has an equivalent weight, 227.7. The acid has thus all the properties and characteristics of myristic acid[8] and is, therefore, identical with it. The alcohol part could not be obtained in crystalline form and is still under investigation.

The chloroform extracted leaves were next percolated with rectified spirit and the percolate freed from chlorophyll as usual. The product thus obtained was a mixture consisting mainly of a highly crystalline non-reducing sweet product and a small proportion of a reducing syrupy mass.

The sweet crystalline compound has a m.p. 187°C., and is highly soluble in water, sparingly soluble in methanol and ethanol and is insoluble in non-polar solvents. It is optically active having specific rotation of +66° in water. Although these properties correspond exactly to those of sucrose, this compound is not sucrose as its mixed m.p. with sucrose is depressed by about 30°C., and unlike sucrose it does not reduce Fehling's solution when hydrolysed with dilute hydrochloric acid. Further examination of this compound has shown that it has a molecular formula, $C_7H_{14}O_6$ and contains one methoxyl group. Althoug it did not give any crystalline acetyl derivative, a crystalline diisopropylidene derivative, m.p. 104°C., could easily be obtained. A thorough search of literature has revealed that pinitol [9,10,11] a monomethyl ether of *d*-inositol, has all these properties in common and, therfore, the compound under investigation is pinitol. We call this compound here 'caesalpinitol' to indicate its source.

The infrared absorption spectral curve of this compound is shown in Fig. 2. It shows a band at 3472-3320 cm.$^{-1}$ indicative of its hydroxyl groups[4] and a C-O-C band[12] at 1125 cm.$^{-1}$ confirming methoxyl group. As expected no other functional groups are indicated by this spectrum.

In view of the fact that caesalpinitol is a monomethyl ether of inositol, which is a growth promoting chemical, it will be of interest to examine its activity in this direction, and the results will be reported later.

The reducing substance has been found to be glucose as indicated by the formation of glucosazone and confirmed by paper chromatography. This reducing sugar is present in the leaves to the extent of 0.109 %.

Experimental

Isolation of the Bitter Priniciple of the Leaves of Caesalpinia bonducella.—Green mature leaves of *Caesalpinia bonducella*, collected in the month of July from the locality of Dacca, were semi-dried by keeping for a few days at room temperature. They were then powdered and extracted as follows: 400 g. of the powder was soaked with 2500 ml. of chloroform in a percolator at room temperature and left overnight. The deep-green extract was then run out drop by drop into a conical flask. Fresh chloroform (1500 ml.) was added to the powder in the percolator and the extraction was carried out similarly. This process of extraction was repeated four times. The combined extracts were passed through a column of charcoal (powdered

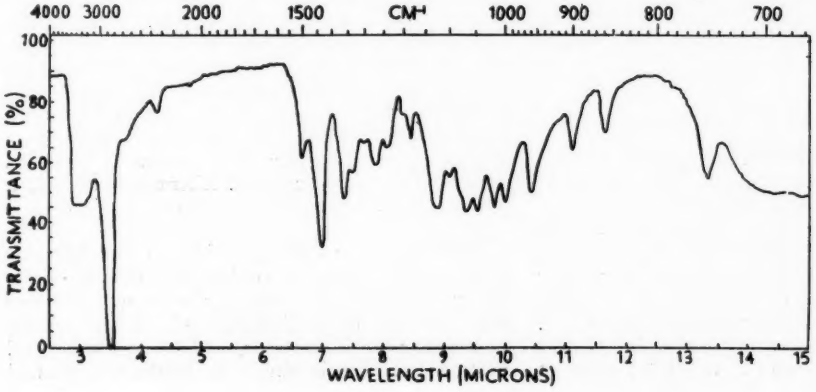

Fig. 2.—Infrared absorption spectra of the event crystalline compound, $C_7H_{14}O_6$, m.p. 187°C. (caesalpinitol).

gas absorbent charcoal) whereby an almost colourless solution was obtained. The minimum size of the column required for this purpose was 36 × 5 cm. The chlorophyll-free chloroform solution thus obtained was distilled under reduced pressure. The solvent was distilled off, leaving a brown viscous mass. Removal of last traces of the solvent from the residue followed by trituration with 100 ml. light petroleum (b.p. 60-80°C.) gave a greyish white precipitate, which was collected by filtration through a Buchner funnel and washed with some more solvent. Drying the precipitate under vacuum at room temperature afforded about 2 g. of an amorphous bitter solid, m.p. 46-65°C. It was highly soluble in ether, acetone, chloroform, benzene, methanol, ethanol and ethyl acetate but was insoluble in petroleum ether and water. It could not be obtained in crystalline form from solvents or mixed solvents. The whole mass was, therefore, dissolved in the minimum volume of chloroform and added on to the top of an alumina column (24 × 2 cm.). The chromatogram was then eluted with a mixture of 2:1 chloroform and light petroleum (b.p. 40-60°C.). The result of this chromatography is given in Table. 1.

The fractions separated were all bitter and amorphous. Thus it will be seen from the table that most of the original stuff was absorbed in the column, which, however, could not be eluted out

TABLE 1.

No. of fractions	Volume collected	Weight of residue after evaporation	m.p. of residue
1—5	5 × 10 ml.	nil	—
6	10 ml.	0.16 g.	90°C.
7	,,	0.24 g.	89°C.
8	,,	0.10 g.	87°C.
9	,,	nil	—

even with boiling methanol, ethanol or chloroform. The separated fractions were combined together and again passed through a column of alumina of the same dimension, and eluted with the same solvent the fractions collected being in portions of 5 ml. The substance began to appear in the 12th fraction and continued up to the 18th fraction after which no further substance came out. All the fractions were amorphous white bitter solids melting at 119-120°C., the total amount being 0.14 g. Further chromatography gave the same results. This compound was highly soluble in common organic solvents except petroleum ether and water, and it could not be crystallised. It was, therefore, dissolved in pure chloroform, filtered from the impurities, the solvent removed and the residue treated with pure light petroleum (b.p. 40-60°C.). The amorphous bitter solid thus obtained was dried by heating at the temperature of boiling acetone under a vacuum of less than 1 mm. of Hg and this was treated as a pure compound. Sodium fusion of this compound followed by subsequent tests of the product for the different elements showed that it did not contain nitrogen, sulphur or halogen. Its elemental analysis and molecular weight determination gave the following results: Found: C, 64.26; H, 7.21; m.w. (Rast) 453. $C_{24}H_{32}O_8$ requires C, 64.28; H, 7.19; m.w. 448.49. Its specific rotation was nil. The substance was insoluble in 10% aqueous sodium hydroxide solution even when boiled. When heated with dilute hydrochloric acid on the steam bath it gradually turned dark brown and then gummy; the filtrate from this acid treatment was neutralised with dilute sodium hydroxide solution and then heated with Fehling's solution but there was no reduction showing that the compound was not a glycoside. Hydroxamic acid test carried out according to the usual method gave an intense violet colour. Infrared absorption spectra of this compound in Nujol mull: $\nu_{max.}$ a shoulder 3596-3460 (OH), 2865, 1749 (ester carbonyl), a weak peak 1508 (furan ring?), 1233 (acetyl group) and a very weak peak 875 (furan ring?) cm.$^{-1}$. The full curve is given in Fig. 1. There was no peak in the ultraviolet absorption spectra between the wavelengths 210-350 mμ of this compound. The following colour reactions were carried out for furan rings in this compound: (a)[1,7] A few mg. of *p*-dimethylaminobenzaldehyde was dissolved in a small quantity of concentrated hydrochloric acid in a test tube and then mixed with a few mg. of the compound; a pink colour developed immediately and persisted for a long time. (b)[5] It was treated with Shear's reagent when a brown-red colour developed on heating which intensified on standing thus giving a positive indication for furan ring. (c)[5] It was treated with a mixture of acetic anhydride and concentrated sulphuric acid when a greenish violet colour was produced. Literature[5] records a green colour.

The solvent of the petroleum ether triturate of the residue from the chloroform extract of the leaves was taken off whereby a brown bitterless waxy residue (3.5 g.) remained. It was soluble in ether, petroleum ether, chloroform and ethyl acetate but was insoluble in methanol, ethanol

and water. Charcoaling did not remove the colour.

Hydrolysis of the Wax.—The wax (3 g.) was mixed with 10% alcoholic potassium hydroxide solution (20 ml.) and the mixture was refluxed on the steam bath for 3 hours. The alcohol was distilled off and the viscous residue was treated with 30 ml. water. The insoluble residue was extracted out continuously with ether. Drying (Na_2SO_4) of the ethereal extract followed by removal of the solvent gave a yellowish semi-solid substance (1.6 g.) which is readily soluble in ether, petroleum ether and chloroform but insoluble in cold methanol or ethanol. Hot methanol, however, dissolved the substance on cooling. Liebermann-Burchard test gave purple-violet colour. This is the alcohol part of the wax and could not be crystallised yet. Investigations on the compound are continuing.

The alkaline aqueous solution left after the ether extraction was acidified with dilute sulphuric acid whereby an oily mass separated, which was extracted out with ether exhaustively. The ethereal extract was washed with water and dried (Na_2SO_4). Removal of the solvent gave a dark brown semi-soild acidic product (0.45 g.). This acid was collected from several experiments and then the crude acid (1.69 g.) was separated into a solid saturated acid (0.23 g.), m.p. 52-54°C., and a brown resinous mass by the method of Twitchell.[13] The solid acid crystallised as white small needles from aqueous alcohol when it melted sharply at 54°C. Further crystallisation did not raise its m.p. Its equivalent weight determined according to the literature method[8] was 227.7 and it gave a crystalline anilide, m.p. 84°C., prepared according to the method of Ahmad and Hahn[14] and crystallised from methyl alcohol.

Isolation of Caesalpinitol from the Leaves.—The residual leaves after the chloroform extraction were percolated at room temperature with rectified spirit (2000 ml.) in a percolator and the mixture was left overnight. The extract was drained out. Two further extractions were similarly carried out each time with about 1000 ml. of the solvent. The combined light green extract was decolourised by passing it through a column of powdered gas absorbent charcoal (36 × 5 cm.). The clear practically colourless solution was then distilled under reduced pressure. The residue was freed from the last traces of solvent by suction with a vacuum pump at about 50°C., whereby a brown viscous syrupy mass (21 g.) was abtained. On standing for a few days at room temperature it was found that a lump of crystal had separated from this syrupy mass. The mass was then stirred with the help of a spatula whereupon the whole mass solidified with evolution of heat. This was dissolved in methanol by refluxing on the steam bath and filtered hot from the impurities. The brown methanolic solution was then seeded with a trace of the above solid and allowed to stand. Prismatic crystals separated, which were collected on the filter, washed with a little fresh solvent and then air-dried. The crystalline product thus obtained was a white substance (16.27 g.), m.p. 187°C. (sharp). Repeated crystallisation from the same solvent did not raise its m.p. It was highly soluble in water, moderately so in hot methanol and ethanol but was insoluble in ether, petroleum ether, chloroform, benzene and ethyl acetate. It was sweet to taste and did not reduce Fehlings' solution. Its specific rotation was $[\alpha]_D^{34}$ (in water) = + 66°. Its mixed m.p. with sucrose, m.p. 187°C., was 163°C. A little of this compound was heated with dilute hydrochloric acid on the steam bath for about 15 minutes, the acid was neutralised with sodium hydroxide solution and then boiled with Fehling's solution, but no reduction took place. Its combustion analysis and molecular weight determination gave the following results: Found: C, 43.49; H, 7.13; m.w. (cryoscopic method using water as solvent) 191.40. Calculated for $C_7H_{14}O_6$: C, 43.31; H, 7.23; m.w. 194.18. Infrared absorption spectra in Nujol mull: $\nu_{max.}$ a shoulder 3472-3320 cm.$^{-1}$ (OH),2880, 1437, 1363, 1125 (-OCH_3) cm.$^{-1}$, complex band between 1070-1000 cm.$^{-1}$, 964, 900, 860 cm.$^{-1}$ (Full curve in Fig. 2).

Qualitative detection of methoxyl group in this compound was carried out according to the method of Tobie[15] by generating methyl iodide by the method of Zeisel and reacting the iodide with mercuric nitrate solution. A prominent vermilion colour developed showing the presence of methoxyl group. Quantitative estimation of methoxyl group by the usual Zeisel's method showed 14.99% of methoxyl group in this compound corresponding to one methoxyl group for the formula $C_7H_{14}O_6$ which theoretically requires 14.76% for one methoxyl group.

Acetylation of this compound was carried out as follows:

(i) The compound (0.5 g.), fused sodium acetate (0.5 g.) and acetic anhydride (4 ml.) were mixed together and heated on the steam bath for 3½ hours. The homogeneous solution was then treated with crushed ice whereby a viscous liquid separated which did not solidify even on long scratching. It was, therefore, extracted with ether, the ethereal extract washed with sodium bicarbonate solution and water and then dried

(Na_2SO_4). Removal of the solvent gave a viscous liquid (0.45 g.) which could not be crystallised.

(ii) The acetylation was then carried out by the method of Griffin and Nelson[16] by warming the compound (0.5 g.) with acetyl bromide (2.2 g.) for about half an hour followed by decomposition of the excess bromide with crushed ice, extraction with ether, washing the ethereal extract successively with sodium bicarbonate solution and water, and then removal of the solvent from the dried (Na_2SO_4) extract. The residual product was a viscous mass which offered similar difficulties for crystallisation. Griffin and Nelson[16] claim that they obtained a crystalline pentacetate of pinitol (pinitol has a molecular formula of $C_7H_{14}O_6$), m.p. 98°C., by this method.

Acetonation of the compound according to the method of Anderson, MacDonald and Fischer[10] by shaking the compound (0.98 g.) with dry acetone containing 1.20% hydrogen chloride (100 ml.) for five hours followed by working up the product gave crystalline diisopropylidene derivative (0.75 g.) needles (from acetone-light petroleum), m.p. 104°C., $[\alpha]_D^{31}$ (in chloroform) $= -30.5°$. (Found: C, 56.53; H, 7.805. Calcd. for $C_{13}H_{22}O_6$: C, 56.85; H, 8.05). Hydrolysis of this diisopropylidene derivative (0.23 g.) by heating on the steam bath for 30 minutes with 2N sulphuric acid (4 ml.) followed by neutralisation of the acid with barium carbonate, removal of the insoluble $BaSO_4$ by filtration, and evaporation of the neutral solution to dryness on the steam bath, gave a white crystalline residue (0.12 g.), m.p. 185°C. Recrystallised from methanol this residue had a m.p. 187°C.; its mixed m.p. with the original compound, m.p. 187°C., was undepressed. Anderson et al.[10] give a m.p. 104.5-106°C. for the diisopropylidene derivative of pinitol and $[\alpha]_D^{23} - 45.5°$ and Angyal et al.[11] record a m.p. 103-104°C. and $[\alpha]_D^{23} - 23.0°$ for this compound.

Reducing Sugar of the Leaves.—The methanolic mother liquor after separation of the sweet crystalline product from the alcohol extract of the leaves was charcoaled but there was practically no improvement of colour. The solvent was, therefore, removed whereby a syrupy brown mass (ca. 4 g.) was left. This residue was reducing as shown by a rapid reduction of Fehling's solution. It gave an osazone, m.p. 204°C., prepared by the usual method; a mixed m.p. of this osazone with an authentic sample of glucosazone, m.p. 204°C., was undepressed indicating that the reducing sugar was glucose.

Paper chromatography of this substance using ethyl acetate: water: acetic acid (3:3:1) as solvent and benzidine as spray reagent showed the presence of only glucose.

This reducing sugar has been estimated by the Schoorl's method[17] which corresponds to 0.109% on the weight of the dry leaves.

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STANDARDIZATION OF SOME LOCAL DRUGS

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Five important local drugs, aconite, *Cinnamomum camphora*, colchicum, male fern and rhubarb have been studied. These were analysed and tested according to standard assay methods. All these drugs come up to standard laid down by I. P. Codex, 1953.

Introduction

Medicinal plants and herbs of great commercial and therapeutic value are known to occur in the north western part of West Pakistan and its tribal territories.[1,7] but no systematic attempt has ever been made to standardize them. Due to lack of such authentic information local pharmacists are reluctant to use these valuable indigenous raw materials for the preparation of galenicals and other medicaments. They, therefore, import crude extracts of these drugs for the manufacture of tinctures and other pharmaceuticals. It has also been commonly observed that some medical practitioners hesitate to use them in their prescriptions because they are doubtful about their quality and they think that they would not get suitable results when administered to their patients. Recognizing the importance of standardization of indigenous pharmacopoeial and non-pharmacopoeial drugs the present work was undertaken and the results obtained have been reported in this paper. This analytical data and information will be useful for those engaged in the practice of medicine and pharmacy.

Materials and Methods

Five important drugs, aconite, *Cinnamomum camphora*, colchicum, male fern and rhubarb were selected for the present study. Samples of crude drugs or herbs were collected from wild sources during the botanical surveys carried out at these laboratories. A few samples were also purchased from the local drug market of Peshawar. Some drugs were freshly analysed mainly because of the volatile nature of their constituents while others were dried in the sun or shade as required and the percentage of active principles was accordingly estimated. All drugs were analysed and tested according to the standard assay methods and the analytical data represent the average of at least three determinations in each case.

General and Experimental

Aconite or 'methatalia' (Urdu) consists of the dried root of *Aconitum chasmanthum* Stapf ex Holmes (N. O. Ranunculaceae) which is found as a beautiful perennial herb in the alpine and subalpine regions of western Himalayas, from Chitral to Guraiz Valley and Azad Kashmir, and also in Upper Hazara in high plateaus between 7,000-12,000 ft.[3] It is found gregariously between Burwai and Gitidas; and is most common at Basal particularly on the sides of the Lalusar Lake. It is the Banbalnag of Azad Kashmir, Mohri of Hazara, Dudhia and Pium of the Himalayas.

The air-dried fresh samples were analysed according to the assay method of the Indian Pharmaceutical Codex 1953 and the results are shown in Table 1.

It was also observed that alcoholic (90 percent) extract of the drug produces with equal volume of

TABLE. 1—LOCAL ACONITE

Month of collection	Locality of collection	Indaconitine %	Ash %	Acid-insoluble ash %	I.P.C. 1953 standards	
					Indaconitine %	Acid-insoluble ash %
October	Kamari (Azad Kashmir)	3.80	4.83	0.20	Not specified	Not more than 1%
October	Lalusar (Kaghan Valley)	3.63	4.50	0.15	4.3	

concentrated sulphuric acid a dark violet coloration, gives white precipitate with 5 per cent silver nitrate solution and yellow precipitate with a saturated solution of picric acid.

Cinnamomum camphora Nees and Eberm.—Cinnamomum camphora, Nees and Eberm (N.O. Lauraceae) or camphor tree is a large handsome evergreen plant and is indigenous to China, Farmosa and Japan. It is planted in some gardens in the plains especially at Abbottabad. It grows well in good soil, and is quite hardy at 4,000 ft.[5,6] It also grows in moist shady places in gardens at Lahore. This plant is a source of camphor which is an official drug of the British Pharmacopoeia.

TABLE 2.—ABBOTTABAD CAMPHOR TREE.

	Average yield of volatile oil in		Camphor in the air-dried sample %	Remarks
	Fresh sample %	air-dried sample %		
Bark	0.02	0.07	nil	Only oil could be obtained from fresh or dried bark.
Leaves	2.20	4.20	1.70	Camphor could be obtained only from air-dried leaves.
Sapwood	0.53	1.70	nil	Only oil could be obtained.
Twigs	0.61	1.50	0.60	Camphor could be obtained only from air-dried twigs.

Samples of both fresh and air-dried bark, leaves, sapwood and twigs were steam-distilled for about three hours for the determination of volatile oil and camphor. In some cases only oil could be obtained while in others oil contaminated with camphor was obtained. Camphor was separated from the oil by a centrifuge and then analysed by following the general principles of the method of the British Pharmacopoeia 1953. The results are given in Table 2.

Colchicum luteum Baker.—Colchicum luteum Baker (N. O. Liliaceae) or 'Suranjan-e-talkh,' is an annual herbaceous plant found extensively growing in the subalpine areas in rakhs and open fields in boardering forests of the Upper Hazara, Murree Hills, Malakand, Kurrum and Khyber agencies at altitudes of 2,000 to 9,000 ft. It is often the first flower (yellow) to bloom on lawns in Abbottabad and Murree from January to March. The plant is locally known as 'Qiamatgul' due to its poisonous nature. It is considered to be a substitute for *C. autumnale* Linn, an official drug of the British Pharamacopoeia.

The drug colchicum corm consists of the fresh corm of the above mentioned plant collected in early spring; or the same deprived of its coats, sliced transversely and dried at a temperature below 65 °C. The drug colchicum seed are the dried ripe seeds of the same herb. Both were analysed according to the methods of I.P.C. 1953 and the results obtained are given in Table 3.

Dryopteris filix-mas (Linn) Schott.—Dryopteris filix-mas (Linn) Schott (Fam. Polypodiaceae) or male

TABLE 3.—LOCAL COLCHICUM.

Locality of collection	Part analysed	Colchicine %	Total ash %	Acid-insoluble ash %	I.P.C. 1953 standards			B.P. 1953 standards for *C. autumnale L.*	
					Colchicine	Total ash	Acid-insoluble ash	Colchicine	Acid-insoluble ash
Abbottabad	Corm, fresh and sliced under water	0.27	2.10	0.12	Not less than 0.2 %	Not specified	Not more than 0.5 %	Not less than 0.25 %	Not more than 0.5%
Abbottabad	Fresh air-dried corm	0.27	2.14	0.13					
Kamari	,,	0.27	2.30	0.13					
Market sample.	Dried corm.	0.20	2.41	0.20					
Market sample.	,,	0.19	2.50	0.21					
Abbottabad	Seeds	0.40	3.38	0.12	Not less than 0.3 %	Not more than 5.0 %	Not more than 1.0 %		
Abbottabad	Seeds	0.44	3.40	0.12					

fern is commonly found in the moist depressions on the northern aspects and other such forests in cooler places in the northern part of West Pakistan like Azad Kashmir, Kaghan Valley and Murree Hills above 6,000 ft.[1] The drug consists of the rhizome, frond bases and apical buds, collected late in autumn, divested of dead portions and the roots are carefully dried, retaining the internal green colour.

Four fresh, air-dried samples of male fern were analysed according to the official assay method of B. P. 1953 and the analytical values are shown in Table 4.

Rheum emodi Wall.—*Rheum emodi* Wall (family Polygonaceae) or 'Rewandchini' is found in subalpine and alpine Himalayas and is common everywhere in Astore and Upper Guraiz Valley at altitudes of 11,000 to 12,000 ft.[4] About 250 maunds can be collected in a season[7] and is usually considered to be the source of the so called Himalayan or Indian rhubarb.

The drug consists of the dried rhizome and roots of this plant or other species of Rheum, collected from 6 to 7 years old plants just before the flowering season, with cortex intact or partially decorticated.

It was found that local rhubarb responds to all tests given in I.P.C. 1953, or B.P. 1953 and gives positive indication for the presence of anthraquinone compounds, emodin and chrysophanic acid. In ultraviolet light it fluoresces deep violet with certain amount also of velvety brown patches and does not contain rhaponticin.

Results and Discussion

Table 1 shows that indigenous aconite comes up to the standards laid down by the Indian Pharmaceutical Codex 1953 and also shows all the identification tests of the said Codex. It is, therefore, concluded that the drug can be put to all the uses enumerated therein in the prescribed doses to get the desired therapeutic results.

Table 2 shows that camphor tree of Abbottabad yields a good percentage of natural camphor and camphor oil which are valuable products for the manufacture of celluloid, disinfectants, medicaments and perfumes. It is, therefore, probable that an industry could be established somewhere near Abbottabad as the tree could be grown easily in moist ravines at about 2,000 to 4,000 ft. above sea level. But in order to achieve this end it is necessary to start a careful cultivation because at present only a few trees exist and they too are being destroyed by the people.

It is evident from Table 3 that corm of *Colchicum luteum* collected from natural source contain a suitable amount of colchicine and is more than the lower pharmacopoeial limit. So it is a good substitute for *C. autumnale* of the British Pharmacopoeia which does not grow at all in Pakistan but its preparations are quite specific for rheumatism and gout. The percentage of the active principle is, no doubt, comparatively low in the market samples. On enquiries it was disclosed by the dealers that fresh corm, just after their extraction from the ground, are put into boiling water for a minute or two and then dried in the sun. This

TABLE 4.—ANALYTICAL VALUES—RHIZOMES OF PAKISTANI MALE FERN.

Date of collection	Locality	Ash %	Acid-insoluble ash %	Ether extract %	Filicin %	B.P. 1953 standards	
						Acid-insoluble ash	Filicin
October	Dungagali (Murree Hills).	3.60	0.34	9.10	3.27	Not more than 2.0%	Not less than 1.50%
September	Shogran (Kaghan Valley)	3.42	0.15	9.51	3.30		
July	Naran (Kaghan Valley)	2.97	0.17	8.97	3.39		
October	Shogran (Kaghan Valley)	3.01	0.14	10.05	3.45		

treatment does not allow them to shrink on drying and they retain their natural shape which is liked very much by the hakims. This defective process of drying is responsible for the low colchicine content of the drug samples purchased from the market. This method should be abandoned and the official method of slicing the fresh corm and then drying them in shade or at a temperature below 65°C. should be followed.

The analytical data obtained with indigenous male fern shows that it is of superior quality and may be used as an anthelmintic. It is reported that the active principle, filicin, is more stable than the crude drug itself which deteriorates within one year.[8] It is, therefore, advisable to extract the resin and store that for use in pharmaceutical industry or export purposes. Local rhubarb also agrees with all the standards and identification tests of both the Indian Pharmaceutical Codex and British Pharmacopoeia. But the drug available from wild sources cannot even feed the local pharmaceutical industry. So in order to obtain a regular supply of the drug of standard quality, a careful cultivation of the medicinal species is necessary. If Himalayan rhubarb is cultivated with due care, there is reason to believe that a drug equal to the Turkish or Chinese rhubarb might be obtained.

Summary

All the five drugs discussed here are of standard quality. But in view of their short supply from wild sources their cultivation should be started at suitable places both to meet the demand of the local industries and for export purposes.

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BIOCHEMICAL AND NUTRITIONAL STUDIES ON EAST PAKISTAN BANANA

Part I.—Investigation on the Mechanism of Banana Ripening by Evaluation of their Auto-Dehydrogenase Activities

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The autodehydrogenase activity of the banana *M. Dacca, Horan*, locally called 'Amrit Sagar,' was studied on different batches attached to and detatched from the stalk during the process of ripening under storage at ordinary room temperature. Side by side the activity in plantain, i.e. cooking banana (*M. paradiciaca*), which does not ripen easily but takes longer period of storage, has also been studied under the same storage conditions. In the case of 'Amrit Sagar' variety it has been observed that bananas attached to the stalk ripened more quickly and elaborated more dehydrogenase activities than those detached from the stalk. In all the batches whether stalked or destalked, the above enzymes were concentrated more in the peel than in the pulp. Among the different regions of the peel and the pulp, the stylar end elaborated more activities than the stem end portion. The significance of the above findings were discussed in the light of the glycolytic breakdown of starch to sugar and other constituents during the different phases of ripening.

Introduction

East Pakistan produces nearly 1.6 million tons of different varieties of banana every year. Among these, the 'Amrit Sagar' variety grows in largest quantity and is popular not only in this country but also in other neighbouring countries for its sweet flavour, softness of the seed-free flesh and other qualities. The cultivation of this variety of banana was previously localised in some regions in the District of Dacca in East Pakistan and perhaps *Sapeintum var Dacca Hort* (M. Dacca, Horan) refers to the above 'Amrit sagar banana.' Watts [1] has described this as 'Dhakai Kela', i.e. and banana originating from Dacca.

A large portion of this and other varieties of banana grown in this region get spoiled during transport by country boat and by storage under ordinary conditions, resulting in a loss of nutritional value. This happens because of the rapidity of the processes through which the different phases of ripening proceed in this tropical, and humid climatic condition of the region.

In many countries of the West and of the East a great deal of work has been done on the control of ripening and delaying its onset during transport and storage and all the work has been reviewed by von Loesecke[2] and others. But no work has yet been done in this country where the problem is much more complicated because of the humid and tropical climatic condition of the region. It was, therefore, thought desirable to study the whole field of the mechanism of ripening and spoilage of different varieties of banana grown in this region so that an economic method or methods may be developed for their transport and storage with curtailment in the loss of the nutritive value due to spoilage.

Storage by chilling in low oxygen and high carbon dioxide atmosphere and by such other methods as adopted in Western countries presents a number of difficulties. Gas storage with CO_2 sometimes deteriorates the quality and produces 'gas injury' characterised by darkening of the skin.[3,4] Storage by extreme chilling causes complete retardation of ripening with formation of dark spots on the skin.[5-8] All the above processes are based on the principle of limiting the hydrolysis of starch either by controlling the respiration with the help of carbon dioxide atmosphere or by inhibition of enzyme activities by chilling.

On survey of the whole process of ripening it is revealed that this is constituted by three separate phases—preclimacteric, climacteric and senescence phases and at each phase different constituents are generated. In reviewing the literature so far collected it appears that the preclimacteric phase is associated with low R. Q. and this is followed by high R. Q. in the climacteric phase. In the senescence phase there is drop of the R.Q. although at a slower rate. The R.Q. again shows a sharp rise if the banana is allowed to overripe and undergo spoilage.[1,9-11] The above changes in the R.Q. are accompanied by gradual breakdown of starch with the production of sucrose, glucose and fructose as has been noted by many workers.[1,12-14] During the breakdown of starch, there is some loss of the total carbohydrates (10 to 15%) and this may be accounted for by simultaneous production of malic, oxalic, citric, succinic and other acids with the fall in the pH value of the pulp [15-20] and of acetaldehyde, amyl acetate etc. leading to aroma [1,21] and formation of anthocyanin, flavones, carotene and anthophyll pigments with simultaneous decrease in the chlorophyll content leading to the production of yellow to brown or reddish colour.[22]

If the bananas are allowed to overripe or undergo spoilage, part of the sugar formed is fermented to ethyl alcohol.[1] Moreover, for acquiring energy for the operation of the different enzymatic processes, part of the starch at the initial stage is directly converted to carbon dioxide and thus cannot be accounted for.

All the above observations lead to postulate that the stored starch in the mature but unripe banana undergoes similar sequences of aerobic and anaerobic degradation by a chain of enzyme systems as are involved in the breakdown of muscle and liver glycogen. Various works showing the involvement of similar pattern of enzymatic pathways in the breakdown as well as in the synthesis of glycogen in the human body and of starch in the plant kingdom, have been reviewed elsewhere.[25] Calvin's recent studies as to the involvement of some more hitherto unknown enzyme systems in the synthesis and breakdown of starch, have added new knowledge to this filed.[24,25] In the background of this information, it will be worthwhile to study the various enzyme systems involved in the different phases of banana ripening and spoilage, so that newer information may be gathered which may help to control the ripening process in a more systematic manner by use of some enzyme inhibitors or activators as may be needed at certain stage of the ripening process.

A series of investigations have, therefore, been started in these Laboratories and in the first of these, the study of the dehydrogenases which are involved in the glycolytic or (amylolytic) breakdown of starch to pyruvic acid and in the Kreb's tricarboxylic acid cycle, has been undertaken with 'Amrit sagar' banana during their storage under ordinary conditions. Similar study has also been made with the plantain or cooking banana (*M. paradiciaca*) which is consumed in this region as vegetable in curries and locally called 'kacha kela' which means green (kacha) banana (kela). This variety generally does not ripen like other varieties under ordinary storage condition but does so very slowly if stored for a prolonged period and it was expected that simultaneous study of the above enzymes in this variety might throw new light to correlate the ripening process with the dehydrogenase and other enzyme activities.

Experimental

Two stalks of the above species of banana, with a number of bunches in each, were collected at their proper maturity in the green condition. A few bunches from each of the stalks were separated from the stalk and the rest were left attached to the stalk to see how far the detachment or attachment to the stalk influences the ripening process and the enzyme activity. These were then hung in a small glass-walled cupboard with an air access at the top and at the bottom. At the initial stage, few samples from the destalked and the stalked bunches were removed from the rest. After each 24-hour storage similar samples were removed from each of the bunches. Circular discs of 1 cm. thickness were sliced from the stylar end, middle and the stem end portions of each sample and the peel and the pulp portions were then separated and the autodehydrogenase activities of these portions were then estimated according to the Thunberg technique described in the pervious report by the authors[26] in their investigation on the mechanism of fish spoilage. The technique is based on the measurement of the time of discharge of methylene blue dye under vacuum in Thunberg tube containing 1 g. tissue extract in phosphate buffer of pH 7.8. According to this technique the dehydrogenases were allowed to act upon the substrates which were supposed to be present in the tissues along with the enzymes.

The above batches ripened at different periods of storage under laboratory temperature of 80-85 °F. and their enzyme activities were studied up to the periods mentioned in Table 1.

TABLE 1

Variety	Condition of storage	Period of storage in days	Remarks
Amrit sagar	Attached to the stalk	5 (fully ripened)	Spoilage started after this period. Enzyme activities studied up-to the ripening period
,,	Detatched from the stalk	8 ,,	
Plantain	Attached to the stalk	15 (not ripened)	Slight yellow colour of the peel on the 12th day.
,,	Detatched from the stalk	15 ,,	No change in colour even after 15 days. Enzyme activity was studied up to 15 days in both batches.

Results and Discussion

The results obtained with the 'Amrit Sagar' variety are presented in Table 2 and the figures in the table indicate the averages of the replicate values of the time of discharge of methylene blue (M.B.) per gram tissue. The enzyme activity may be calculated as the reciprocal of the above time of discharge of M. B.

TABLE 2.—THE TIME OF DISCHARGE OF THE METHYLENE BLUE DYE (M.B.) BY 1 g. TISSUE OF THE DIFFERENT PORTIONS OF PEEL AND PULP OF THE BANANA UNDER THE VARIETY *Sapientum var Dacca Hort* (*M. Dacca, Horan*) LOCALLY CALLED 'AMRIT SAGAR KELA'. THE ROOM TEMPERATURE DURING STORAGE WAS 80 - 85 °F.

Time of storage in days	Bunches attached to stalk					Hands detatched from stalk				
	Colour of the peel*	Peel (Pe) or Pulp (Pu)	Time of discharge of M.B.			Colour of the peel*	Peel (Pe) or Pulp (Pu)	Time of discharge of M.B.		
			Stylar end	Middle	Stem end			Stylar end	Middle	Stem end
0	G	Pu	← 8 hrs. →			G	Pu	← 8 hrs. →		
		Pe	← 6 hrs. →				Pe	← 6 hrs. →		
1	G - Y	Pu	2h - 20m	3h - 40m	4h - 10m	G	Pu	← 6½ hrs. →		
		Pe	1h - 10m	1h -40 m	2h - 34m		Pe	← 5 hrs. →		
2	G - Y	Pu	52m	1h - 20m	1h - 40m	G - Y	Pu	3h - 10m	3h - 40m	4h - 54m
		Pe	42m	1h - 2m	1h - 24m		Pe	2h - 2m	2h - 30m	3h - 10m
3	Y	Pu	42m	52m	1h - 10m	G - Y	Pu	2h - 40m	3h - 18m	3h - 34m
		Pe	31m	33m	1h - 3m		Pe	1h - 48m	2h - 10m	2h - 30m
4	Y	Pu	52m	46m	1h - 3m	G - Y	Pu	2h - 12m	2h - 48m	3h - 2m
		Pe	20m	32m	45m		Pe	1h - 4m	1h - 32m	1 - 58m
5	B - Y	Pu	22m	31m	48m	Y	Pu	2h - 2 m	2h - 10m	2h - 32m
		Pe	10m	15m	18m		Pe	48m	53m	1h - 6m
6	Spoilage started in the batches.					Y	Pu	1h - 20m	1h - 45m	2h - 0m
							Pe	40m	48m	56m
7						Y	Pu	55m	1h - 15m	1h - 38m
							Pe	30m	38m	52m
8						B - Y	Pu	42m	58m	1h - 10m
							Pe	20m	29m	40m

* G denotes green.
Y ,, yellow.
B ,, brown.

G - Y denotes greenish yellow.
B - Y ,, brownish yellow.

From the data it would appear that all the bananas of the bunches attached to the stalk started ripening from the 3rd day when the colour of the peel changed to yellow and further to brown yellow colour on the 5th day. After this period the bananas of these bunches showed overripening and spoilage. In the bunches detached from the stalk slow ripening started from the 5th day. In these bunches overripening and spoilage started after 8th day storage.

While surveying the data of the dehydrogenase activities, it seems evident that at the initial stage prior to storage very negligible activity was elaborated by the green banana as evident from the requirement of longer period for the discharge of the M.B. by the different portions of the peel and the pulp at that stage. The bananas in the bunches attached to the stalk showed the generation of the dehydrogenase activity after 24 hours storage and within the next 48 hours the value showed a further increase at a steeper rate after which the rate of increase of the activity slowed down until on the last day of the ripening. In the bananas of the bunches detached from the stalk the above enzymes elaborated slight activity late after 48 hours and thereafter the rate of increase of the activities proceeded very slowly up to the last day of the ripening period.

While comparing the activities of the peel with those of the pulp it is noted that at all the stages of ripening the activites were concentrated more in the peel than in the pulp. This indicates that the ripening of the pulp perhaps starts from the surface just beneath the peel due to the influence of the high level of dehydrogenases or other enzymes concentrated in the peel and then gradually proceeds towards the interior of the pulp.

Comparison of the activities located in different portions of the peel and the pulp in both the batches showed a very high concentration towards the stylar end and gradual decrease towards the stem end. This parallels with the gradation of ripening which shows an advance at the stylar end.

From the survey of the data, it is also revealed that at a particular period of storage the bunches detached from the stalk showed lower degree of ripening accompanied by lower dehydrogenase activities as compared to those attached to the stalk. On the basis of these findings it will not be unreasonable to assume that perhaps the stalk is the store house for all the enzymes involved in the ripening of bananas wherefrom these are translocated to the hands and then to the peel. The possibility of the presence of some factor in the stalk which aids in the synthesis of the enzymes in the hands for ripening or of some co-factor which aids, supplements or accelerates the activities of the ripening enzymes already synthesised in the stalk independently, cannot be overruled. Further work is in progress to explore the above possibilities.

Investigation with plantain (cooking banana) revealed complete absence or a very negligible amount of the above enzyme systems at the initial stage before storage and even after storage for a prolonged period up to 15 days as was evident from the consumption of more than 12 hours for the discharge of the dye M.B. In case of the bunches attached to the stalk slight activity was noted after 12 days storage as was evident from the consumption of only 3 hrs. for discharge of M.B. dye. Since the activity of dehydrogenases in all the batches was not very significant, the data for plantain were, therefore, not shown in the table. But it is apparently true that the non-ripening of plantain for prolonged storage under similar conditions is due to absence of the dehydrogenase and other enzymes which are involved in the breakdown of starch to sugar and other constituents. A thorough investigtion has now been started to see if the above apparent absence of the deydrogenases in the plantain is due to complete absence of the mechanism for the synthesis of the above and other enzymes in this variety or due to blockage of the activities of these enzyme systems by some inhibitor or inhibitors.

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INFRARED ABSORPTION ANALYSIS OF SOME EAST PAKISTANI CLAYS

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Infrared absorption spectroscopic study of Bijaipur clay and Mirpur clay (red and black) samples of East Pakistan has been made by the use of a double beamed infrared spectrophotometer. Clay samples of requisite particle sizes have been prepared. Characteristic absorptions given by all the three clay samples under examination are identical with those of the clay mineral, kaolinite.

Introduction

The mineralogical composition of clay determines to a great extent its physico-chemical properties and its suitability for uses in industries. Infrared absorption spectroscopy is, at present, a well developed technique for identification of clay minerals present in a clay. This technique, although developed recently, has attracted a number of workers, e.g. Hunt,[1] Keller and Pickett,[2] Hunt and Turner,[3] Adler,[4] Farmer,[5] Stubican[6] who have employed this technique to the study of various clay minerals and related materials. In their publications they have reported the results of infrared absorption analysis of the chief clay minerals and have discussed various related problems. The Indian workers Atma Ram et al.,[7] and Bishui and Prasad,[8] have also employed this technique for the mineralogical study of some Indian clays. In a recent review, Nahin[9] has discussed the present position of infrared absorption analysis of clay minerals and its future application to possible fields.

Infrared absorption analysis has not yet been used for the study of any Pakistani clay. In view of this fact and of the increasing application of this technique to the study of clay minerals, the authors have employed this technique to the mineralogical study of some East Pakistani clays which are present in abundance and can be put to various uses.

Experimental

Preparation of Samples.—Particle size requirement is crucial for obtaining definitive infrared spectra of a mineral. Keller observed that clay or mineral particles having diameters smaller than 5 microns were required for obtaining a good infrared spectrogram. The clay samples under examination were prepared according to the method given by Hunt and Turner.[3] About 5 g. of a clay sample was dispersed in 250 ml. of distilled water using about 15 ml. of 0.2 normal sodium oxalate solution. The mixture was vigorously stirred in a long beaker for about 15 minutes and was then poured into a 250 ml. measuring cylinder and was allowed to stand for two hours. At the end of this time the upper 10 ml. of the suspention were drawn off without disturbing the rest and centrifuged to separate the solid from the liquid. The solid then dried in an oven between 105° and 110°C. for about 24 hours and was kept in a desiccator for future use. A sample, thus prepared, contained requisite clay particles having diameters smaller than 5 microns and about 0.15 - 0.2 g. of such a sample was sufficient for taking infrared spectra.

Some of the samples of the clays under study were prepared in the above manner using concentrated ammonium hydroxide solution as the dispersing agent in accordance with the method given by Mackenzie.[10,11] These samples gave identical results with the former ones.

Procedure.—A double beamed 'Infracord' Spectrophotometer (Parkin and Elmer, Model 137), was used for recording the infrared spectra of the clay samples under study. An oven dried sample was powdered in a small agate mortar and some of this powder was placed on the sodium chloride window of the spectrophotometer. A few drops of anhydrous isopropyl alcohol was then added to form a paste which was smoothed out on the window with a microscope slide whose edges were polished to prevent scratching. On removal of the slide the alcohol evaporated away and a thin film of clay sample was formed on the window. The window with the thin clay film in it was inserted in the sample beam of the spectrophotometer and the blank sodium chloride window was placed in the reference beam. The film thickness was so adjusted that an initial transmission of 60% was obtained. This method of preparation of a thin film on the sodium chloride window was adopted from that of Hunt.[1]

Results and Discussion

Infrared absorption spectra of the clay samples under study are given in Fig. 1 to 3, and the

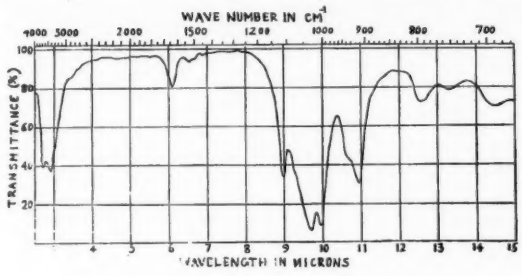

Fig. 1.—Infrared spectra of Bijaipur clay, Mymemsingh.

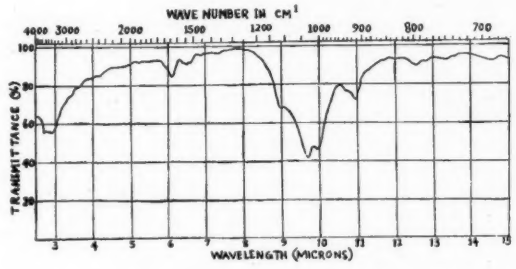

Fig. 2.—Infrared spectra of black caly, Mirpur, Dacca.

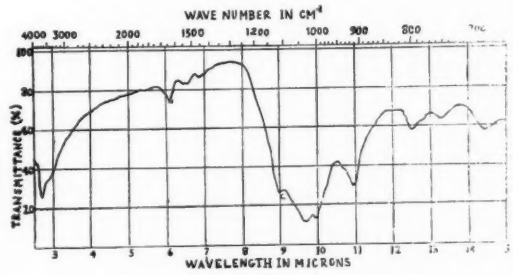

Fig. 3.—Infrared spectra of red caly, Mirpur, Dacca.

position of individual absorption band centres with their relative intensities are given in Table 1. The results of the chemical analysis of the clay samples are given in Table 2.

The main absorption characteristics in these infrared spectra of the clay samples under sutdy,

TABLE 1.—ABSORPTION BANDS OF BIJAIPUR AND MIRPUR CLAYS.

Absorption bands of Bijaipur clay at microns	Absorption bands of Mirpur Clay (Red variety) at microns	Absorption bands of Mirpur clay (black variety) at microns
2.72 (s)*	2.72 (s)*	2.72 (s)*
2.91 (s)	2.95 (w)	2.93 (s)
6.09 (w)	6.10 (w)	6.07 (w)
6.51 (vvw)	6.50 (vvw)	6.48 (vvw)
8.98 (s)	8.97 (s)	8.97 (s)
9.70 (s)	9.69 (s)	9.69 (s)
9.95 (s)	9.95 (s)	9.94 (s)
10.70 (w)	10.68 (w)	10.70 (w)
10.94 (s)	10.95 (s)	10.94 (s)
12.51 (w)	12.61 (w)	12.55 (w)
12.71 (vw)	12.76 (vw)	12.79 (vw)
13.29 (vvw)	13.26 (vvw)	13.21 (vvw)
14.44 (vw)	14.56 (vw)	14.45 (vw)

* (s), (w), (vw) and (vvw) correspond to intensities of strong, weak, very weak and very very weak denominations, respectively.

TABLE 2.—CHEMICAL ANALYSES OF BIJAIPUR AND MIRPUR CLAYS.

Clay	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	Ignition Loss (%)
Bijaipur clay	57.09	30.04	0.32	0.04	0.21	0.11	trace	11.99
Mirpur clay (Red variety)	55.96	23.07	9.57	0.14	0.23	0.12	trace	10.21
Mirpur clay (Black variety)	48.79	26.46	2.50	0.21	0.06	0.04	trace	21.50

are similar. In all the three spectra absorption peaks are all identical. Bijaipur clay has given the strongest absorption peaks while the other two samples of Mirpur clay have produced absorption of lesser intensities. The spectrogram of Bijaipur clay is identical with those of standard kaolinite[1, 8] mineral and consists of the diagnostic doublet in the region 9.65 to 9.90 microns, a shoulder like formation near 10.70 micron, and a singlet at about 10.95 micron. Although absorption spectrogram of Bijaipur clay differs from those of Mirpur clay samples in absorption intensities, they are fundamentally similar and are of the same mineral. The three clay samples, therefore, contains the same kaolinite clay mineral, but the Mirpur clay samples contain varying proportions of impurities. Chemical analyses of these three clay samples given in Table 2 have also indicated that Mirpur clay (both red and black varieties) contains varying proportion of impurities while Bijaipur clay contains the least amount of impurities and is the purest of the clay samples under study.

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CHEMICAL STUDIES ON FUMARIA PARVIFLORA LAMK

Part I.—Nonalkaloidal Constituents of the Plant

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An examination of the leaves and stem of *Fumaria parviflora* Lamk has disclosed the presence of pentatriacontane, glucose, tannin, fumeric acid and sufficient amount of potassium nitrate and potassium chloride.

Introduction

Fumaria parviflora Lamk, known in Pakistan by the names 'shahtarah' (Urdu), 'pitpapra' (Punjabi) and 'papra' or 'bansulpha' (Bengali), is a weed of cultivation and is commonly found in wheat or rice fields belonging to the family *Fumariaceae*. It is a small, much branched, annual, slender herb with much divided leaves and whitish or pink flowers with purple tips in terminal. [1,2,3] The plant is bitter, acrid and astringent. Interest in the investigation of this plant has been evoked by the fact that an infusion prepared from the leaves and stem is used in the indigenous system of medicine as alterative, diaphoretic, diuretic, febrifuge and tonic. Besides, it is said to be expectorant, laxative, blood purifier and cooling. It is an ingredient of some Unani preparations which are sometimes used for the eradication of certain skin diseases, stomach derangement, liver complaints and other ailments. [4,5,6]

The literature shows that no prior investigation of this herb has been reported for its chemical constituents. But *Fumaria officinalis* Linn or Fumitory, [7,8] a closely related species indigenous to England and some other European countries, has been investigated by a number of workers. Agarwal in 1937 reported the presence of pentatriacontane, glucose, inorganic salts and an already known alkaloid, protopine, from *F. officinalis*. [9] In 1938 Manske revealed that the same herb contains not less than seven alkaloids besides other neutral substances. [10]

The present plant after processing in the customary manner for alkaloidal compounds gave positive tests for the presence of alkaloids. A preliminary investigation showed that the dried overground portion of the flowering plant collected in February-March contained approximately 0.24 per cent of total alkaloids determined gravimetrically. Their isolation, characterization and chromatographic study will be reported at a later stage. In this communication only an account of the nonalkaloidal principles of the herb has been given. As a result of the present work it has been revealed that the plant contains a paraffin hydrocarbon, *n*-pentatriacontane (0.5%), glucose (5.4%) fumaric acid and more than 1 per cent inorganic salts comprising potassium chloride (30.3%) and potassium nitrate (69.7%), and about 1 per cent tannin. The diuretic property of the drug may be attributed to the presence of a fairly large amount of these potassium salts.

Experimental

Source of Plant Material.—The material used consisted of the overground portion of the plant *F. parviflora* Lamk comprising leaves and stem collected from the vicinity of the Peshawar University in the month of February-March and the same dried in the shade at room temperature. The herb was supplied by Mr. M. A. Kazmi who authenticated the specimen of *F. parviflora* for preservation in the Herbarium of the Indigenous Drugs Research Division, North Regional Laboratories, Peshawar.

Extractives.—A weighed and finely ground sample was extracted with different solvents in a continuous Soxhlet apparatus for about six hours taking fresh material each time. The total extractive obtained in each case was freed of the solvent, dried on a water bath at 100°C. and weighed. The results are given in Table 1.

Extraction and Isolation of the Constituents.—3000 g. of the air-dried herb consisting of overground portion of the mature flowering plants were dialysed with ten times hot rectified spirit. The combined dialysate on removal of the solvent below 45°C. under reduced pressure gave a thick dark green mass (615 g.; 20.5% on dry basis) with rhombic plates embedded with long needles in a fairly large amount.

Isolation of n-Pentatriacontane, $C_{35}H_{72}$.—The green extract on cooling deposited a flocculent crop of white crystalline precipitate which was filtered (FA). The filtrate was extracted with successive portions of petroleum ether until the extraction was complete (3000 ml.). Petroleum ether was recovered whereby waxy mass (91.56 g.; 3.05%) was obtained. It was dissolved in hot alcohol and saponified with 200 ml. of alcoholic potassium

hydroxide for about six hours. After saponification, most of the alcohol was distilled off under reduced pressure and the soap was dissolved in distilled water. The non-saponifiable matter was extracted with petroleum ether. The petroleum ether extract was washed with distilled water, dried over anhydrous sodium sulphate and filtered. Solvent was recovered from this filtrate when an orange coloured residue was left behind (15.9 g.; 0.53%). It was dissolved in warm alcohol, charcoaled and filtered hot. On cooling small needle shaped crystals were separated out which were filtered and washed with cold alcohol. It was then recrystallized in the same manner and dried over anhydrous calcium chloride; yield 0.5 per cent; m.p. 75-76°C. The substance was neutral, colourless and odourless, gave no test for steroids, and burned with a non-smoky flame, characteristic of saturated paraffin hydrocarbons. It was readily soluble in benzene, soluble in warm alcohol, sparingly so in boiling ether and insoluble in water. It did not decolourise bromine in chloroform. Its mixed m.p.

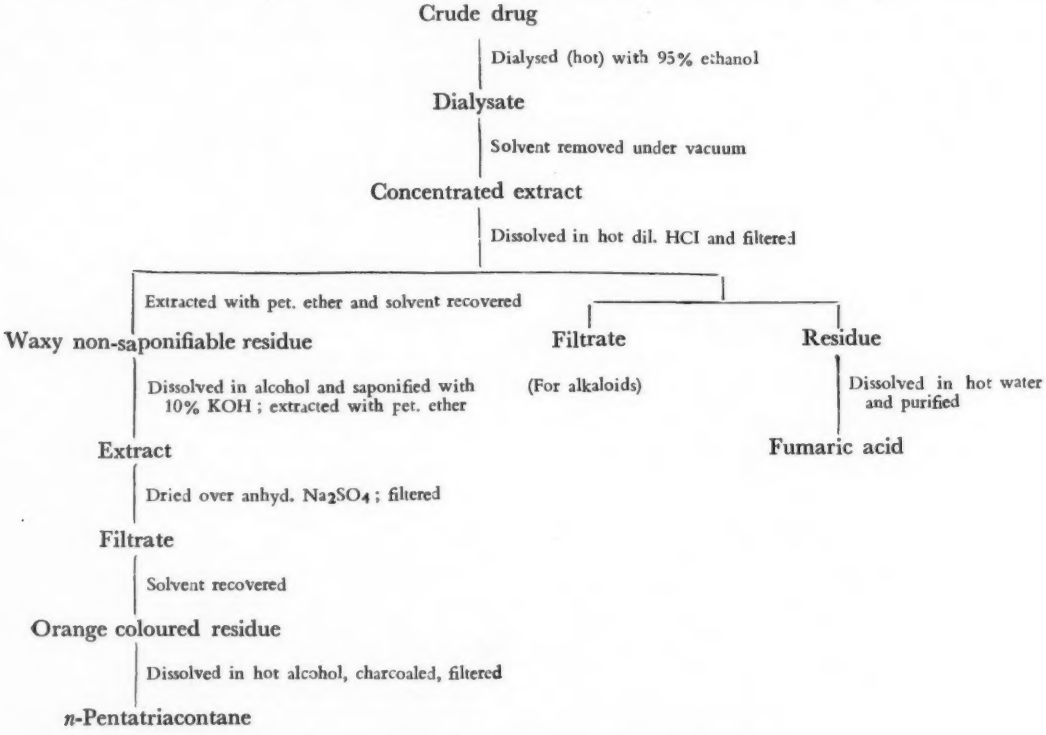

Fig. 1.—Scheme for isolation of *n*-pentatriacontane and fumaric acid.

TABLE I.

Solvent	Extractive %	Remarks
Ether	4.75	Waxy green mass giving weak test for alkaloids.
Pet. ether (b. p. 40-60°C.)	3.33	Waxy green mass containing no alkaloids.
Benzene	4.85	Waxy yellow green mass giving alkaloids tests.
Chloroform	5.99	Yellow green sticky mass giving tests for the presence of sugars and alkaloids.
Ethyl acetate	7.81	Yellow green product giving test for alkaloids and sugars.
Alcohol (95%)	20.30	Yellow green mass giving tests for the presence of tannin, alkaloids and sugars. Inorganic crystals were deposited on cooling the concentrated extract.

with an authentic sample of pentatriacontane obtained from *F. officinalis* Linn. remained unaltered, one pound of which was made available to the author through the kind co-operation of Dr. J. L. Broadbent of the Smith, Kline & French Research Institute, London, to whom thanks are due.

Isolation of Inorganic Salts.—Defatted concentrated extract of the plant obtained after the extraction of chlorophyll and fats with petroleum ether was concentrated, cooled and filtered. A second copious crop of light brown crystals was obtained (FB). The two crops of crystals, F A and FB were combined, dried, extracted with chloroform to remove colouring matter, and then dissolved in a suitable quantity of distilled water and treated with animal charcoal to decolourise it. It was filtered and on cooling a mixture of rhombic plates and long needles was obtained. A second crop of these inorganic salts was obtained by further concentrating the mother liquor to a small volume (39 g., yield 1.3%). On qualitative examination it was found to be a mixture of potassium chloride and potassium nitrate. On quantitative analysis of a standard solution of the said mixture by titrating it with N/10 silver nitrate solution it was found to contain 30.3% potassium chloride and 69.7% potassium nitrate.

The defatted concentrated extract of the plant free of inorganic salts was found to contain more than 1 per cent tannin which were precipitated out with zinc acetate and potassium ferrocyanide. This tannin-free aqueous solution was diluted and found to contain a fairly large amount of reducing sugars. On treatment with phenylhydrazine an osazone, m.p. 206°C., was formed and identified to be glucosazone showing thereby that the herb contains glucose. Following the Lane-Eynons' standard method[11] for the determination of sugars it was found that the plant contains 5.4% glucose.

Isolation of Fumaric Acid.—A portion of the crude extract of the herb was dissolved in hot dillute hydrochlorie acid and filtered. The residue was extracted with hot distilled water, charcoaled and filtered hot. On cooling a crop of fumaric acid was obtained which was again crystallized in the same manner. Melting point, 286-287°C. of this acid with an authentic sample of fumaric acid obtained from *F. officinalis* did not disclose any difference.

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SHORT COMMUNICATIONS

A NOTE ON THE SYSTEMATIC POSITION OF SANTONIN-CONTAINING ARTEMISIA OF KURRAM

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Statement of Qazilbash[5] that *Artemisia kurramensis* Qazilbash has been confused by me[1] with *Artemisia maritima* L and that my conclusion is arbitrary and not based on any original judicious scientific studies does not seem to be justified in the least. These remarks have necessitated a more detailed report on the results of my investigations which lead me to the conclusion that *Artimisia kurramensis* is not a new species different from *Artemisia maritima*. The author has worked on the systematic position of Kurram *Artemisia* at the herbaria of Royal Botanical Gardens, Kew and British Museum, London. The specimens investigated besides his own collection also included two specimens of Qazilbash's *Artemisia kurramensis* sent by him. On the basis of these investigations it has been established that Qazilbash's enthusiasm[7] to create a new species under the name of *Artemisia kurramensis* is not based on scientific facts. The perusal of his various publications[5-9] reveals his confused and shifting basis for creating this new species. He has split up santonin-containing and santonin-free plants growing side by side and hybridising freely as separate species in spite of his admission that no botanical distinction was made between the santonin-containing and santonin-free form of *Artemisia maritima* in the principal herbaria of Europe.[7]

According to Qazilbash[7] the santonin-containing species of the Kurram is characterised by the following diagnostic features.

(i) Leaves and flower heads are hoary and tomentose.
(ii) Involucral bracts 16 to 24 in number, the commonest number in typical cases is 22.
(iii) The usual number of florets is 3 in a capitulum. The colour of the corolla tube is yellow.
(iv) Apical marginal hairs are present on the involucral bracts.
(v) A well marked unbranched midrib is present in the bracts.

The author after his extensive observations on a large number of plants has failed to find any correlation between the above mentioned characters and presence of santonin in the Kurram plants. The leaves and flowers are hoary and tomentose in both the santonin-containing and santonin-free plants. The number of involucral bracts varies from 11 to 34 showing great variations from plant to plant and also within the same plant. The common number of flowers per capitulum is 3 but in the same plant it was found to vary from 2 to 6 in some cases. As far as the colour of the corolla tube is concerned the observations showed that only 84.7 per cent plants have yellow flowers and the rest have pinkish to purple tinge. Apical marginal hairs were generally found to be present on the involucral bracts in both santonin-containing and santonin-free plants. The well marked unbranched midrib in the bracts was observed in all the plants examined without any exception. In addition to the above mentioned characteristic features Qazilbash[8] also made distinction between santonin-containing and santonin-free plants on the basis of intensity of camphor like smell and colour of the stem but he does not make use of this as diagnostic feature in his subsequent publication.[7] In view of the above mentioned facts there seem to be no reliable morphological differences between the santonin-containing and santonin-free plants. In one of his later publications Qazilbash himself admits[6] that there are no reliable botanical features on the basis of which it is possible to distinguish the santonin-containing from the santonin-free *Artemisia*. In the same manner Shah has found[10] no correlation between the morphological characters and santonin. So it is clear that the mere fact that some plants contain santonin does not justify its being treated as a new species. This is specially so when it is known that santonin is not a reliable character as it shows great fluctuations in different stages of plant growth in the santonin-containing plants.

A comparison of the specimens of santonin-containing *Artemisia* from Kurram in the Herbaria of the Royal Botanical Gradens, Kew, and the British Museum, London, showed that these plants were in fact *Artemisia maritima* L. var. *fragrans* (Willd) Ledeb. This includes both the santonins containing and santonin-free plants of Kurram. *Artemisia maritima* is a very widely distributed species growing under extreme ecological conditions. The study of the morphology reveals great variations in the population of *Artemisia*

Fig. 1.—Santonin-containing *Artemisia* from Kurram named as *A. kurramensis* by Qazilbash and determined by the author to be *A. maritima* L. var. *fragrans* (Willd) Ledeb.

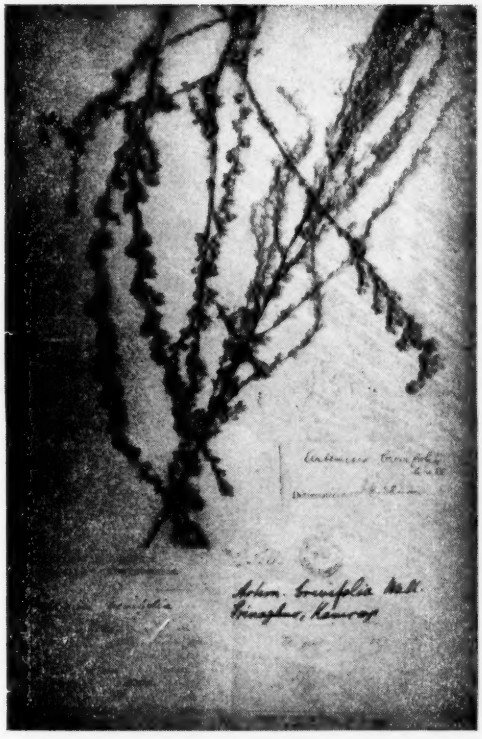

Fig. 2.—*A. maritima* L. var. *genuina* Ledeb. f. *suberecta* (Ledeb) Pamp. This specimen from the herbarium of Royal Botanic Gradens, Kew, was identified by Sir J. D. Hooker as *A. maritima*, L. and *A. brevifolia* Wallich was considered synonym by him.

maritima. This is probably due to apomixis, hybridization, polyploidy and mutations. Observations show that *Artemisia maritima* population in West Pakistan follows a definite pattern of variations with gradual transition from one type to the other. When specimens of *Artemisia maritima* from Baluchistan are compared with those from Gilgit, they look so different that it would seem natural for one not familiar with the full range of variations in *Artemisia maritima* to treat these as distinct species but on study of specimens from the intervening regions gradual transition from one form to the other can be observed. The variable nature of the population makes the taxonomic studies difficult. The only satisfactory way of dealing with such variable species is by experimental analysis when the exact relationship of the members of the various groups can be elucidated. The chromosome studies have already thrown some light on the possibility of *Artemisia maritima* being a single huge polyploid complex. [3, 11, 12] Weinedel and Polya have determined the basic somatic chromosome number of *Artemisia maritima* as 18.[2] So it is not true that *Artemisia maritima* in typical cases is a hexaploid as has been claimed by Qazilbash.[5] Suzuka[12] determined the chromosome numbers of both so-called species *Artemisia kurramensis* and *Artemisia brevifolia* from the seeds supplied by Qazilbash and found them to be diploid and tetraploid respectively with basic chromosome number as 9. According to Pampanini[4] the correct name of santonin-containing *Artemisia* of Gilgit is *Artemisia maritima* L. var. *genuina* Ledeb f. *suberecta* (Ledeb) Pamp and not *Artemisia brevifolia* Wall as stated by Qazilbash.[5] *Artemisia maritima* L. subsp. *monogyna* Waldst et Kit., which is a source of santonin in Japan, was found to be hexaploid with 54 chromosomes. According to Kawatani et al[3] santonin-free *Artemisia* from Kurram has 36 chromosomes. The somatic chromosome numbers of *Artemisia maritima* thus vary from 18 to 54 and the chromosome number alone has no basis for the separation of species. The following statement of Qazilbash[5i] tself clearly removes the confusion created unnecessarily

Fig. 3.—Specimen of *A. brevifolia* Wallich from the herbarium of British Museum, London, named as *A. maritima* L. var. *genuina* Ledeb. f. *suberecta* (Ledeb) Pamp. by Pampanini.

that *Artemisia kurramensis* is nothing but *Artemisia maritima*.

"It is interesting to note in this connection that hexaploids derived artificially from *Artemisia kurramensis* Qazilbash, on treatment with acenapthene resembled *Artemisia maritima* L. morphologically as well as genetically in all important respects. The artificially produced plants were sent to the Kew Botanic Gardens for confirmation. They were identified as similiar to *Artemisia maritima* L. (P. 68)". This statement of Qazilbash is self explanatory and even a person not connected with science of systemtic botany knows that mere change in the number of chromosomes does not justify creation of a new species. According to Qazilbash's own statements[5, 7] *Artemisia kurramensis* has never been recognised by the herbaria of the Royal Botanical Garden, Kew, and other principal herbaria of Europe. The fact that this name has been adopted by some pharmaceutical scientists without critically examining its validity does not make it a universally recoginsed valid species as claimed by Qazilbash.[5]

Pending the determination of the fixed nature of various varieties and subspecies of *Artemisia maritima* it is not desirable to split it into a number of species on the basis of unreliable contrasting characters like the presence or absence of santonin. On the basis of the above facts it is clear that santonin-containing *Artemisia* is just a variety properly named as *Artemisia maritima* L. var. *fragrans* (Willd) Ledeb. It is for the taxonomists to judge whether these investigations carried out at the herbaria of the Royal Botanical Garden, Kew, and the British Musuem, London, constitute judicious scientific studies or not. On the other hand one would wonder what led Qazilbash to create a new species without any valid basis.

My sincerest thanks are due to Mr. S. A. Afzal for his assistance in this work. Thanks are also due to the Director of the Herbaria of the Royal Botanical Gardens, Kew, and the British Museum, London, for providing all necessary facilities for this work.

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EFFECT OF VIRIDIN ON THE GROWTH AND INFECTIVITY OF SCLEROTIUM CEPIVORUM BERK †

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Sclerotium cepivorum causes serious losses in England by producing white rot disease on onion (*Allium cepa*), garlic (*A. sativum*), shallot (*A. ascalonicum*) and leek (*A. porrum*). Studies made by Ghaffar[1] indicated that *S. cepivorum* was strongly antagonised in plate culture by a number of soil micro-organisms. Of these *Trichoderma viride* (in the wide sense of Bisby[2]) a common soil inhabitant, inhibited the growth of the fungus and produced a characteristic coiling around of the hyphae of *S. cepivorum*. *T. viride* is known to produce an antibiotic, viridin, which has great fungistatic properties (Brian et al.[3]). Experiments were therefore made to study this effect of viridin on the growth and infectivity of *S. cepivorum*.

Methods for the assay of antibiotics are well summarised by Florey et al.[4] Weindling[5] used a visual killing effect of *Trichoderma* filtrates on the hyphae of *Rhizoctonia solani* as his criterion for antibiotic activity. In the present investigation, a 'disk immersion technique' was developed which also shows loss of infectivity by *S. cepivorum* after treatments with the antibiotic.

A sample of viridin, in pure form, supplied by Dr. Brian was used in this test. Followng the technique of Brian et al.[3], 2 mg. of viridin was dissolved in 4 ml. ethanol and made upto 200 ml. in McIlvaine's buffer at pH 3.4 at which the antibiotic substance is stable (Dr. Brian's personal communication). This was further diluted in buffer solution to give a series of concentrations of 1-100 μg. of viridin per ml. Controls were kept in which no antibiotic was used.

The isolate of *S. cepivorum* used was No. 388 in the culture collection of the Botany Department, University of Birmingham. Several groups of 5 mm. diam. disks from an actively growing edge of *S. cepivorum* colony on Czapek-Dox yeast agar*

Fig. 1.—Onion root tip, infected with *S. cepivorum* from disks treated with non-toxic solutions. (Photomicrograph × 100).

Fig. 2.—Onion root tip, healthy/uninfected from disks treated with toxic solutions. (Photomicograph × 100).

†This work was carried out at the Department of Botany, The University, Birmingham, England.

*$NaNO_3$, 2.0 g.; KH_2PO_4, 1.0 g.; KCl, 0.5 g.; $MgSO_4.7H_2O$, 0.5 g.; $FeSO_4$, 0.01 g.; sucrose, 30.0 g.; yeast extract, 2.0 g.; agar, 20.0 g.; distilled water, 1000.0 ml.

TABLE 1.—ANTIBIOTIC ACTIVITY OF AN AQUEOUS SOLUTION OF VIRIDIN TOWARDS *S. cepivorum* AS ASSAYED BY 'DISK IMMERSION TECHNIQUE.'

Treatment	Concentration of viridin (µg./ml.) 0	1	5	10	25	50	75	100
	No. of disks giving *S. cepivorum* infection*							
1. 5 mm. diam. disks of *S. cepivorum* inoculum immersed in test solutions for (minutes)								
0	10	.	.	.	.	.	.	.
5	10	10	10	4	4	0	0	0
15	10	10	10	0	0	0	0	0
30	10	10	10	0	0	0	0	0
60	10	10	10	0	0	0	0	0
Overnight, 10 hours	10	10	10	0	0	0	0	0
2. As in 1, but washed in distilled water after immersion of the disks.								
0	10	.	.	.	.	.	.	.
5	10	10	10	10	10	10	8	8
15	10	10	10	10	10	2	2	2
30	10	10	10	10	4	0	0	0
60	10	10	10	0	0	0	0	0
Overnight, 10 hours	10	10	10	0	0	0	0	0

*Observations based on 10 disks per treatment.

were immersed in the test solutions for 0, 5, 15, 30, 60 minutes and overnight (10 hours). These disks were then transferred to a moist chamber of a Petri dish and on them were placed pieces, 6-8 mm. long, of roots of onion seedlings (var. white lisbon) germinated on filter paper. When left overnight for about 10 hours at laboratory temperature these root tips become infected from untreated disks of *S. cepivorum* inoculum or when the disks are treated with non-toxic solutions, but the toxic solutions prevented infection (compare Figs. 1 and 2). A summary of the results from these treatments is presented in Table 1. A period of immersion of the disks from 30-60 minutes enables one to determine the antibiotic effects. Washing

TABLE 2.—STABILITY IN ANTIBIOTIC EFFECTS OF VIRIDIN AGAINST *S. cepivorum*.

Concentration of viridin µg./ml.	No. of disks giving *S. cepivorum* infection* 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Storage in days														
0-5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10
25	0	0	0	0	0	0	0	0	0	0	6	10	10	10	10
50-100	No infection														

*Observations based on 10 disks per treatment.

of the disks does not remove the effects especially after treatments in higher concentrations of viridin.

An experiment was then conducted to study the stability of aqueous solutions of viridin during storage. Different concentrations of viridin prepared above were kept at laboratory temperature in flasks plugged with cotton wool and similarly assayed over a period of 14 days. The time for immersion of the disks was one hour. The results are presented in Table 2. Fresh aqueous solutions of viridin were active from a concentration of 10 µg. upto 100 µg. /ml. in preventing infection of onion root tips by *S. cepivorum*. However, storage beyond 10 days resulted in a gradual loss of antibiotic activity in the weaker solutions of viridin, while at concentrations of 50 to 100 µg. of viridin per ml. the solutions remained toxic after 14 days of storage at laboratory temperature.

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NEUTRINO AND THE CHANGING OF CONCEPTS

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In 1955 the author drew up a theory on beta emission based on the concept that the neutrino rest mass was equal to that of the electron. This was based on the physical laws of invariance, neutrino being the isotopic spin invariant of the electron. Also on the constancy of e/m, measured by Thomson and also of e, measured by Millikan which proves that mass does not exist below the level of the electron, as no sub-electrons have any possibility of existence. This paper was finally published in the Pakistan Journal of Science, Vol. 8, No. 3, May 1956.

The author referred the theory to the late Professor E. O. Lawrence, who was kind enough to refer it to experts. Some interesting correspondence was exchanged and it was finally conceded that the neutrino mass could be $1/50 \times$ mass of electron as against **Pauli's** concept of its being 1/2000th of the mass of the electron. For obvious reasons, the author could not change his view.

The mass of the neutrino was evaluated by J. J. Sakurai (Physical Review letters, June, 1, 1958 and its elaboration later) based on H^3 - Hc^3 mass difference, utilising parity non-conservation and measureng accurately the shape of the beta spectrum near the end point. He came to the conclusion that the mass of the neutrino could not exceed 1 kilo electron volts, that is $1/500 \times$ mass of the electron, provided the law of conservation of mass and energy held good.

On the other hand, the work of Lee and Yang on the non-conservation of parity in weak interactions by itself, should create an imbalance on the two sides of the mass-energy equation, if the neutrino is non-vanishing, which it is. That meant a breakdown in the law of conservation of mass and energy and, if it was so, as it is, why could not neutrino equal the mass of the electron, in keeping with the laws of invariance and indirect evidence from Thomson's and Millikan's experiments.

Further, as mentioned in the letter to the late Professor Lawrence, the mass difference of the neutron and proton was so much and the computation of mass-engergy in the equation and the way neutron breaks up left one in little doubt that the neutrino, the smallest neutral particle of matter, could belong to the electron - positron family.

In another publication (Pakistan Journal of Science, Vol. 10, No. 1, January 1958), the author examined the problem from another angle. The uncertainty principle was applied for two simultaneous events (electron - neutrino exchange to establish n - p forces) and an approximate relationship was developed :

$$R_{e,\nu} \simeq \frac{h^2}{m^2c^2}$$

where c was relatable to m. The above relationship could not be discarded on the theory of dimensions because: (a) there could be slight, though very slight difference in the speed of e and ν, (b) the relationship was for two particles and not one, possibly moving skew - symmetrically to the line of reference even though it defined the internucleonic distance all right.

Based on the consideration that e and ν mass were equivalent, the value of c came to be 10^8cm./sec., e_m being 9×10^{-28} g./sec. In other words, by the process of *reductio-ad-absurdum*, there was a breakdown of the law of conservation of mass and energy in nuclear fields, which is 10^{36} times the corresponding gravitational field. At very high temperatures, the thermodynamical kinetic motion of the nucleons, weakened this field and brought it well within the realm, where the law is an accepted basis of nuclear physics. Similarly, in strong interactions.

The author can make a reference to Einstein's *Treatise on Relativity* (Princeton University Press) and mention that the law of conservation of mass and energy was derived from the consideration that if the field equations were satisfied and the variation was a transformation variation, all the terms vanish, so that the field equations imply the equation $(g^{ik}\ \delta U^s{}_{ik})_\mu = 0$

With the simplest special choice of ξ^i independent of the X, leads to the four equations:

$$I^s{}_{ik} \equiv (g^{ik}\ U^s{}_{ik\lambda})_\mu = 0$$

These can be interpreted as the equations of conservations of momentum and energy.

On the other hand, applying the method of enumeration to determining the strength of the system of equations and taking into account the fact that all the U* obtained from a given U by λ - transformation represent the same U - field,

we get $Z_d = 42$ as against $Z_d = 12$ for pure gravitational field. Thus the field equations of the non-symmetric field are considerably weaker than those of the pure gravitational field.

In the general theory of relativity, therefore, the system of equations defining the law of conservation of mass and energy is very unlikely to hold good in the nuclear fields, which are 10^{36} times stronger than the corresponding gravitational field. A new system of equations has, therefore, to be developed, based on the characteristics of the nuclear forces and Einstein's own suggestion to: (a) increase the dimension of the continuum, (b) introduction of fields of different kind, and (c) introduction of field equations of higher order. Then alone the field equations should define mass - energy relationship in nuclear fields.

For this reason the unitary equation is highly unlikely to be formulated—we have two sets of physical phenomena to be defined and, to the author's view, another set of equations has, to be developed from the general theory of relativity to define the inside-the-nucleus phenomena (and even non-conservation of parity in weak interactions).

This is of considerable importance, on the practical side, in nuclear reactors. By feeding the current produced by the reactor to produce strong electrostatic fields around the fuel rods to reduce the nuclear field, even intermittently, it could be possible to excercise fuel economy and also to produce power reactors from less enriched fuel.

The economic and scientific implication of this concept is expected to have a revolutionising influence on reactor technology.

The extent of deviation in the special theory of relativity will be defined (not determined because of the very small energy of the neutrino to account for spin and statistics in beta emission) by the difference in the beta spectrum curve and the ideal straight line.

NOTES & NEWS

Chromite and Coal Deposits in West Pakistan

The Geological Survey of Pakistan has found large deposits of chromite near Tangi, about 30 miles from Peshawar, and of lignite coal in Dadu district.

The chromite deposit was found after a detailed survey at a distance of about 9 miles from Tangi. The reserve of chromite could not so far be estimated, but it is reported to be quite rich. For the extraction of chromite, a plant will be installed at Hindubagh (Baluchistan) or Rohri.

The deposits of lignite are spread over an area of about 40 to 50 square miles near Kirchar hill ranges in Dadu district. They are estimated to be over 30 million tons. Samples of coal have been sent to Lurgis in West Gremany for analysis.

Master Plan on Waterlogging and Salinity

Pakistan is faced with a menace of waterlogging and salinity which has been progressively rendering large tracts of otherwise cultivable lands into arid zones. The Water and Power Development Authority has been entrusted with the responsibility of meeting the challenge. In May 1961, the Authority finalised a Master Plan of Rs. 350 crores to check waterlogging and salinity. The report on the Plan runs into 60 pages and comprises an overall appraisal of the problem of waterlogging and salinity besides the future programme to control the menace with minimum expenditure. Data of the affected land included in the Plan has been obtained from the investigations carried out so far in different parts of West Pakistan. The Master Plan also gives an assessment of the results of various projects under implementation besides working out details of the future reclamation programme. Implementation of the Plan will be spread over a period of ten years.

P.I.D.C. Chemical Plant

The Pakistan Industrial Development Corporation has set up the Kurram Chemical Company at Rawalpindi. The plant is expected to go into production shortly. After receiving finishing touches, the Laboratory of the Company has already started functioning with the analysis of Artemisia.

It will begin production of Santonin, a drug for round worms very shortly. The annual production of Santonin will be 18,000 pounds. Most of this productlon will be exported to Europe and Korea from where export orders have been received. Raw material for the factory is obtained from the Kurram Agency in the former North West Frontier Province.

Nutritional Survey of Pakistan

The Directorate of Nutrition Survey and Research, Government of Pakistan, in collaboration with UNICEF, F. A. O. and WHO, will launch a nation-wide survey in order to collect data on the level of food consumption, the dietary habits of the people of different regions, the differences between the patterns of food consumption among urban and rural populations, and the effect of seasonal variations on food availability and the consumption levels. In addition, the assessment of other factors, apart from the factor of purchasing power, influencing dietary practices, particularly among agricultural and non-agricultural labour force, has been envisaged in the survey scheme. It is proposed to appraise the effect of all these and related factors on the nutritional status of the national population so as to enable the Government to devise and organise ways and means to effect improvements by instituting remedial measures.

The Directorate, first of all, would obtain actual data from all over the country to make preliminary estimates of inadequacies in food consumption levels and to appraise their effect on the health of the nation. Information gathered through door-to-door enquiry will be subjected to nutritional scrutiny. The cross-section of population involved would also be medically examined in a clinical survey. There would also be a biochemical survey.

The survey plan would involve a three-pronged investigation of the problems of malnutrition and under-nutrition to the extent of their prevalence in urban and rural areas by regions, groups of people, and seasonal variations.

The operation has been divided into four stages, (i) Planning and organization (including statistical sampling which is in final stages). (ii) Recruitment of personnel and their training. (iii) Pilot survey. (iv) Country-wide survey.

Negotiations are in progress with the National Institute of Health, Bethesda, Maryland, U.S.A. for services of experts and executives to the Directorate of Nutrition Survey and Research. Three executives of the Institute have already arrived to finalise an agreement on Government level for an assistance of nearly 274,000 dollars.

The project is a part of a development scheme for operation under the Second Five-Year Plan and has been sanctioned by the Government at an estimated cost of Rs. 6.62 lakhs spread over two to three years.

Leather Development Centre

The National Small Industries Corporation has decided to set up a Service Centre at Karachi for the development of footwear leather industry at an estimated cost of Rs. 6 lakhs. The centre will aim at introducing new processing methods and will increase the general level of industrial productivity.

The shoe industry is the second largest small-scale industry in Karachi employing more than 5,000 workers.

The Service Centre will render advice and technical guidance to small units on improved technical processes and information on the use of modern machinery and equipment. It will also carry out research on indigenous raw materials and find ways and means for substitution of imported materials by indigenous raw materials.

The Centre will be a pilot project which is expected to eventually attract co-operatives and associations to set up similar facility centre on co-operative basis. A sum of Rs. 3 lakhs is expected to be spent on import of machinery and equipment.

Power Commission Appointed

On May 12, 1961 the Government of Pakistan announced the appointment of a 10-man Power Commission with Dr. I. H. Usmani as its Chairman.

Following are the terms of reference of the Commission:—

a) To determine the power requirement of the country and to make recommendations regarding sources of power generation, including nuclear power, to meet the requirement.

b) To conduct comprehensive examination of the power rates obtaining in the country and to make recommendations for their rationalization with particular reference to cheap supply of power to boost up production taking into consideration the special needs of under-developed areas.

c) To suggest revision of electric rules with reasonable safety requirements.

d) To recommend agencies for generation, transmission and distribution of power in the light of local conditions.

e) To examine the need for a permanent organization in each province to supervise matters relating to distribution of power and fixation of power rates.

f) To consider whether power should be supplied at a low rate in order to encourage industrialization, and capital involved amortized through other means such as taxation on the industrial products.

g) To make any other relevant recommendations.

The Commission consists of the following members:—

Mr. Zahuruddin Ahmad, Joint Secretary Ministry of Finance; Mr. S. A. Sobhan, Joint Secretary, Ministry of Industries; Mr. A. H. Khan, Commissioner Power Development, East Pakistan WAPDA; Mr. A. Hamid, Chief Engineer, Electricity, West Pakistan WAPDA; Dr. M. S. Qureshi, Chief, Water and Power Section, Planning Commission; Mr. M. A. Rangoonwala, Federation of Pakistan Chambers of Commerce and Industry, Karachi; Sardar Barkat Hayat Khan, Managing Director, the Rawalpindi Electric Power Co. Ltd., Rawalpindi; Mr. M. A. Jalil, Managing Director, Amin Jute Mills, Chittagong; Mian Allah Bux, Chief Conservator of Forests (Retd.), Toha Teh Singh, District Lyallpur.

Modern Gas Plant in Scotland

Britain's first Lurgi high-pressure gasification plant has been completed by Humphreys and Glasgow Limited of London, at Westfield, Fife, in the East of Scotland. The total cost of the project is estimated to be £ 6,600,000. The plant now produces 15 million cu. ft. of gas per day. With the completion of the second stage of the plant, the output will be doubled to give a daily total of 30 million cu. ft. of gas, the equivalent of one-fifth of Scotland's present consumption.

The Lurgi principle of pressure gasification of low-grade coal, conceived in Germany, was adapted by Humphreys and Glasgow to meet the Scottish needs. The plant uses 450 tons of coal per day hitherto useless for gas making. It runs itself by automatic means with a modicum of supervision. The temperature, the pressure, the quantity and the calorific value of the gas are all automatically measured and adjusted to keep the end-product of uniform character suitable for the requirements of distribution.

The raw Lurgi gas is in itself unsuitable as a town gas and has subsequently to be washed, purified and enriched to make it suitable for distribution to consumers.

Exhibition of Building Materials at the National Health Centre, Rawalpindi

With the object of acquainting the architects and engineers with the building material being produced in the country, an exhibition was held in September 1961 at the laboratories of the National Health Centre, Rawalpindi. The Pakistan Council of Scientific and Industrial Research displayed the following material developed at their laboratories:

(1) Foam concrete, (2) Cuprosinol wood preservative, (3) Fixemper (alkali-proof dry distemper), (4) Pakcem for waterproof cement paint, (5) Waterproof coloured cement for concrete flooring, (6) Jutoid waterproof matting, (7) Cemto (cement waterproofiing powder), (8) Gas plant, (9) Marbolite (synthetic marble), (10) Cellular clay bricks for thermal insulation especially in cold storage construction, (11) Chips boards from wood waste, (12) insulation boards from bagasse.

The material displayed by other organisations included table taps, laboratory fittings etc. It appeared that there was hardly any building material worth the name being produced in the country. This statement does not include cement clay bricks industries.

Mr. Bukhari of the National Health Centre arranged visits of leading engineers and architects associated with the Capital Development Authority and Pakistan Public Works Department.

New Journal

An international journal, *Corrosion Science*, containing original papers, short notes and critical reviews on every aspect of corrosion science, has been introduced from August 1961. It is published quarterly by the Pergamon Press Ltd., under the auspices of the Corrosion Science Society and the Centre Belge de l'Etide de la Corrosion with the assistance of an international editorial board. The annual subscription is £7 or $20.

Chemical, metallurgical and engineering journals in many countries publish papers on corrosion; there are also several national publications dealing solely with corrosion and protection topics. It is hoped the new international journal will form a link between corrosion scientists the world over, and will come to provide each of them with a selection of the most interesting papers from the world's corrosion laboratories.

T. B. Research Institute

A National Tuberculosis Research Institute will be set up by Pakistan Government, with the assistance of the UNICEF and the W. H. O. at Rawalpindi next year.

A comprehensive survey for prevalance of tuberculosis is being carried out in various parts of Pakistan. The T.B. Survey team comprising of 15 Pakistani and 5 international experts, which started its work last year, has so far surveyed the areas of Karachi, Lahore and Rawalpindi.

With the setting up of a T.B. Control centre at Dacca recently, three subsidiary centres at Sylhet, Chittagong and Rajshahi have been opened. These sub-centres are increasing the number of cases under treatment with isonicotinic tablets, which the UNICEF is providing.

Ten more sub-centres would be opened shortly in various regions of East Pakistan.

Glass-Sheet Factory

A big glass-sheet manufacturing factory set up at Chittagong has gone into production.

Set up on an area of about 11 acres of land, the Usmania Glass Sheet Factory is a private

enterprize producing about 25,000 sq. ft. of glass sheet daily.

It is estimated that the total production of the factory will be more than sufficient to meet the demand of the country. The sponsors of the factory hope to compete in the international market.

With the help of three German Experts the factory is producing high quality plain sheets, ice flower sheets, window sheets and monogram glass-sheets and in the near future, it is expected to produce mirrors.

It is hoped that the Middle East and Far East countries will be prospective markets for these glass sheets produced by automatic process.

Next CENTO Scientific Body Meeting in Lahore

The CENTO Scientific Council will hold its next session in Lahore in January, 1962. The Council, which recently concluded its session in Tehran has broadened the terms of reference of the Council to comprise general consultation on scientific matters among the scientists of the member countries.

The next Council meeting scheduled to be held in Lahore will be followed immediately by the second CENTO Scientific Symposium on the role of scientific research in the development of natural resources. The United States of America will attend the session and the seminar for the first time as a full member of the Council.

Amcrica was voted for a full member at the Tehran moot where the Scientific Advisers' Fund has been doubled from this year's amount of 15,000 pounds to 30,000 pounds.

BOOK NOTICES

Progress in Reaction Kinetics. Edited by G. Porter. Volume. I. 272 pp. Pergamon Press, London, 1961. Price 70s.

This is the first volume in an important new series which will publish authoritative review articles on chemical kinetics, summarizing progress and significant developments in this field. The emphasis is on the quantitative aspects of the subject but the volumes will cover the whole field of kinetics, from elementary reactions in gases to complex organic and biochemical processes.

Each review is written by a leading authority in the field and while the latest developments are fully discussed a clear summary of earlier work is included so that the articles will be of value not only to the specialist but also to those who require a more comprehensive and up-to-date account than is to be found in standard text books.

Each of the nine articles in this volume reviews recent advances in a particular field and any scientist who is really interested in one of these reviews will find something of interest in all the others.

The Use of Oxygen in the Electrometallurgy of Steel. G. M. Borodulin. Translated from Russian by G. F. Modlen and edited by H. T. Protheroe. 112 pp. Pergamon Press, London, 1961. Price 50s. ($9.00)

It is difficult to overestimate the importance of the use of oxygen in electric steel melting practice. At first the greatest use of oxygen took place in the melting of stainless chrome-nickel and chromium steels of specification $IK_{1}8N9T$ and IKh13-4Kh13. Then the range of types of steel was broadened. In this book, translated from Russian, the use of oxygen is examined in the electro-melting of stainless, transformer, cracking, high-speed, chromium nickel structural, ball-bearing and high-carbon tool steel. Information is presented about the quality of metal melted with the use of oxygen, and about the technico-economic details of the process.

The productivity of electric furnaces has considerably increased in this connection, the cost of steel has decreased, its quality has improved and in certain steels rejects have been completely eliminated. This volume will be of great value for foremen and engineer-electric steel melters, and will be extremely useful to students of advanced metallurgy.

Telomerization and New Synthetic Materials. R. Kh. Freidlina and Sh. A. Karapetyan. Translated from Russian by Margaret F. Mullins and edited by B. P. Mullins. 102 pp. Pergamon Press, London, 1961. Price 25s. ($4.50)

This is the first book devoted to an exposition of telomerization reactions. The result of intensive Russian research, this reaction makes it possible to obtain the intermediate products for the production of new synthetic fibres, plastics, perfumes and other industrial products from cheap starting materials—for example, from natural and industrial gases. A detailed description is given of the formation and properties of the new synthetic fibre "enanth" which possesses more valuable properties than caprone and nylon.

The importance and industrial uses of the tetrachloroalkanes as chemical intermediates is especially carefully described and will be of particular interest since there is no previous treatment of this subject.

This important new work, although dealing with modern organic chemical research, requires of the reader only an average school knowledge of the fundamentals of physics and chemistry.

Regional Neurochemistry. Proceedings of the Fourth International Neurochemical Symposium, Varenna, Italy. Edited by S. S. Kety and J. Elkes. 540 pp. Pergamon Press, London, 1961. Price 84s. ($12.00).

This volume contains the forty-seven papers presented at the Fourth International Neurochemical Symposium held at the Villa Monastero in Varenna which was attended by neurochemists from many parts of the world. It represents the fourth of a continuing series of volumes which jointly covers the main areas of the chemistry of the nervous system in health and disease.

As with the three previous Symposia the Organizing Committee selected a topic considered to be of growing importance in neurochemistry and its congnate fields. In this year's subject *The Regional Chemistry, Physiology and Pharmacology of the Nervous System* there lies a recognition of one organizational complexity. It is this complexity, well adapted to subserve function, which makes the particular site of a chemical reaction in the brain a parameter of equal importance to substrate and enzyme activity in determining outcome. In the nervous system, more than in any other place in the body, biochemistry recognizes its dependance on structure as well as the contributions it may make to, or receive from, other disciplines.

This volume which incorporates the formal papers and some of the discussion at the Fourth Symposium will convey much of the depth and breadth of the field as it exists today.

Moisture Determination by the Karl Fischer Reagent. British Drug Houses Ltd., Poole, England. Second edition, 1961. 15 pp.

After many attempts to determine water chemically, a simple and widely applicable procedure was described by Karl Fischer in 1935, and this method with certain refinements is now used extensively.

The booklet describes methods of preparing the Karl Fischer reagent, the detection of endpoint, the apparatus for direct titration, general procedure and standardization of the reagent, and extraction of water from samples under examination. The varying applications of the Karl Fischer reagent have been briefly reviewed.

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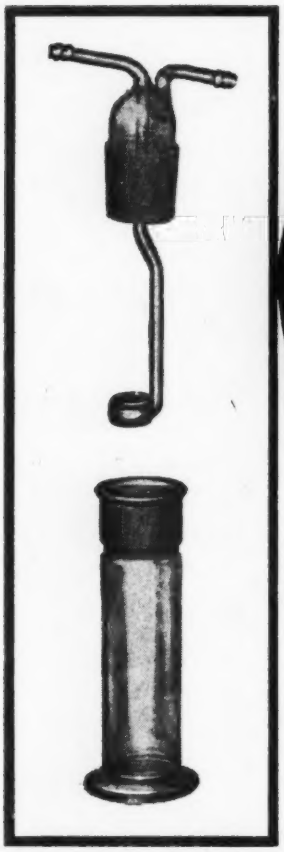

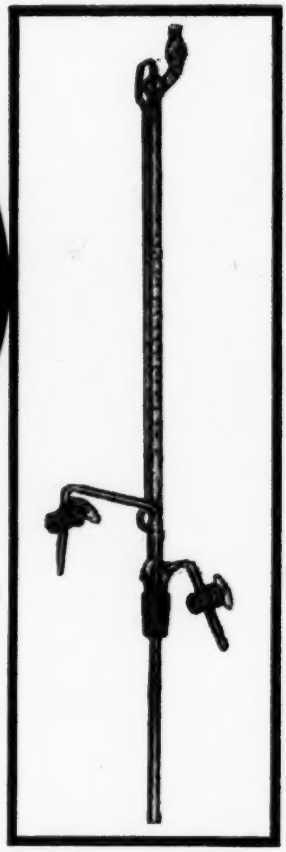

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